ELECTRICAL REVIEW

ILLUSTRATED.

A WEEKLY JOURNAL OF

Electric Light, Power, Telephone, Telegraph and Scientific Progress.

VOL. 15, No. 19. WEEKLY.

NEW YORK, SATURDAY, JANUARY 4, 1890.

$3 per annum. Single Copies, 10 Cents.

Copyright, 1890, by ELECTRICAL REVIEW PUBLISHING COMPANY, 13 Park Row, New York.

Entered at Post Office, New York, as Mail Matter of the Second Class.

Electric Air-Line Transportation.

The illustration on this page is from a suggestion by Dr. G. P. Hachenberg, of Austin, Texas. The doctor describes his plan at some length in a communication to the REVIEW, which we publish below. The idea is, we think, an original one, and, given a passenger who is not afflicted with dizziness, is not to be classed as impracticable. The details of construction are fairly well shown in our artist's sketch, made from a rough drawing sent in by the author, and a good idea is given of what might be expected should the scheme ever be put in use. The illustration differs slightly from the description in some minor details. The Doctor writes:

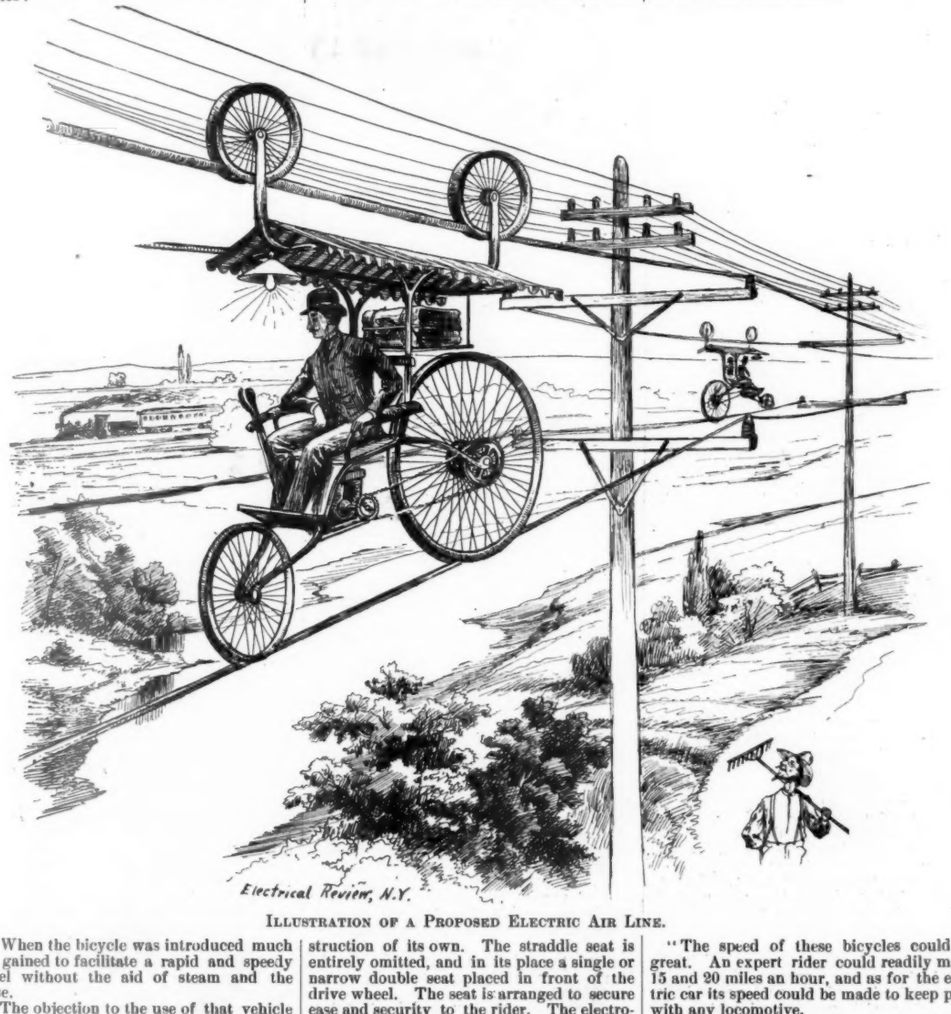


ILLUSTRATION OF A PROPOSED ELECTRIC AIR LINE.

"When the bicycle was introduced much was gained to facilitate a rapid and speedy travel without the aid of steam and the horse.

"The objection to the use of that vehicle is the skill and practice required to manage it, and it is only available on a comparatively level surface. To meet these objections, and, at the same time to increase speed in the use of the bicycle, to an extraordinary degree, I would make the following suggestion:

"In the first place have constructed a line of two heavy wires, one above the other, about 10 feet apart, as represented in the sketch. These wires are adjusted to poles and both are held in an exact high tension, ascertained by an accurate measured force. The bicycles are to run on these wires—are constructed with grooved wheels, the couplet of wheels for the upper wire being grooved the deeper to securely hold the vehicle in a direct line and to favor reversing it.

"For travel on wires, two kinds of motors are used. The one, the rider himself, and the other, electricity—the electric power taken from the upper wire. If deemed necessary both vehicles carry electric lights.

"The construction of these bicycles vary from those used on the ground. On the wire, the guiding rod is fixed, and not used for guiding purposes; but simply for the rider to hold on to. In the cross-piece receiving the piece supporting the drive wheel is a joint to reverse the machine to run it the opposite way.

"The electro-bicycle has a peculiar construction of its own. The straddle seat is entirely omitted, and in its place a single or narrow double seat placed in front of the drive wheel. The seat is arranged to secure ease and security to the rider. The electro-motor is placed under the seat. The place to mount these bicycles, or to reverse their action are usually at one of the poles, by stepping on the lower arm which may be but a few feet from the ground. It may be readily seen, the electro-bicycle is well adapted for the accommodation of a lady, and without the electric power can be pushed ahead by the rider.

"It may be a good arrangement to have the third wire—the electric wire—strung a foot or two above the upper one. Give it the same tension; but let it carry but little weight. It will then not alone be an electric wire, but will serve besides as a means of positive safety in case of a break of either o the other two.

"These wires could be so adjusted as to utilize them for telegraphic and telephonic purposes, or the present overland telegraphic poles, at many places, could be used for air-traveling. Such an adjunct to railroads might serve advantageously in many ways.

"These air-line wires are strung close to the ground, except in crossing streams, deep depression, road crossing, etc., where the lower one may be at places 20 feet or more from the ground. The idea is not to maintain the uniform grade of a railroad, yet still as much as possible to bridge over small irregular depressions of the surface.

"The speed of these bicycles could be great. An expert rider could readily make 15 and 20 miles an hour, and as for the electric car its speed could be made to keep pace with any locomotive.

"These lines could serve commercial interests by connecting neighboring towns, or cities and suburbs, in the absence of railroads.

"But their best purpose would be subserved in effecting the rapid transmission of the mail, and transportation of light and condensed packages. It is practicable for such a method of conveyance to convey the mail from New York to Chicago in 10 hours, and from New York to this place (Austin, Texas) within 24 hours. The mail and goods that could be daily transmitted on a single line from New York would be many hundred tons a day."

THE BROOKLYN SUBWAYS.

FINAL REPORT OF THE COMMISSION—INTERESTING REVIEW OF THE UNDERGROUND AND OTHER WIRE WORK IN BROOKLYN.

The official end of the Subway Commission of Brooklyn occurred October 31st, 1889. This report of the commission was handed to Mayor Chapin of that city December 23, and is published in full below. The members of the commission were Prof. George W. Plympton, Rossiter W. Raymond and John Reynolds, and these three gentlemen composed an intelligent, industrious and broad-gauged board whose work was creditable and practicable.

THE REPORT.

Hon. ALFRED C. CHAPIN, Mayor of Brooklyn:

Dear Sir—The Board of Commissioners of Electrical Subways for the city of Brooklyn has the honor to submit the following final report of its work:

The aggregate length of conductors underground has been increased during the eleven months ending October 31, 1889, about 839 miles. The length of telephone cable attached to the elevated railway structure during the same period is about seven miles, carrying 644 miles of conductors. The total milage of conductors now underground in the city (apart from city wires) is 3,007 miles; on the elevated railways (apart from electric light wires), 768 miles. The aggregate thus removed from house-tops and poles is larger than the total of aerial telegraph and telephone wires existing in the city in 1885, when this board was organized.

During the eleven months, 1.418 miles of addional conduits, mostly short connections, carrying 7.862 miles of ducts, and having a capacity of 786 miles of conductors, have been constructed. The telephone company has removed 71 poles, making the aggregate number of poles removed (not including those removed this year by the electric light companies, from which no report has been received), 445. And the telephone wires have been removed from 271 poles, which are still standing, because they carry city wires. The total number of poles which would have been removed by this time if the necessary co-operation of the city had not been delayed, is 677.

For details of the work, reference is made to the appended reports of the different companies.

Permits have been granted by the city, upon the approval of the board, for the following additional conduits:

	FEET.
On Atlantic ave. from 16 Smith st. to Flatbush ave.	3,200
On Third ave. from Atlantic ave. to 16th st.	6,600
On 16th st. from Fifth ave. to Hamilton ave.	2,075
On Bush st. from Hamilton ave. to Dwight st.	2,900
On Sullivan st. from Dwight st. to Ferris st.	1,200
On Flatbush ave. from Fifth ave. (around plaza) to Ninth ave	3,600
On Waverly ave. from Fulton st. to Myrtle ave	3,200
On Grand ave. from Fulton st. to Lexington ave	1,620
On Franklin ave. from Fulton st. to B. B. R. R. depot (Atlantic ave.)	750
On Montague st. from Court st. to Furman st.	2,100
On Hooper st. from Broadway to Kent ave.	3,020
On Division ave. from Broadway to Kent ave.	3,600
On Boerum st. from Broadway to Bushwick ave	2,450
On Van Cott st. from Graham ave. to Union ave	200
On Union ave. from Ainslie st. to Van Cott st.	2,640
On Grand st. from Union ave. to Kent ave.	4,150
On N. 8th st. from Union ave. to Kent ave.	3,020
Total	46,375

or 8.77 miles, having the capacity to receive 3,500 miles of wire.

These additional conduits represent mainly the extension of the subway system into those remoter parts of the city which cannot be reached by cables attached to the elevated railways, and which, through the rapid increase of the number of telephone subscribers, can now be served to a large extent by trunk cables with terminal distributing lines.

The application of the telephone company for the following further additional routes has been approved by the board, but permits have not yet been granted for its construction by the city authorities. The list therefore represents work which the company stands ready to do, if permitted.

	FEET.
On Smith st. from 16 Smith st. to Hamilton ave.	5,800
On Sackett st. from Smith st. to Hamilton ave.	3,600
On Hamilton ave. from 16th st. to Hamilton Ferry	6,400
On Union st. from Third ave. to Ninth ave.	4,340
On Jay st. from Myrtle ave. to John st.	3,400
On Main st. from Front st. to Water st.	300
On Water st. from Main st. to Fulton st.	1,200
On Brooklyn ave. from Fulton st. to DeGraw st.	3,020
On Bedford ave. from Fulton st. to Myrtle st.	4,525
On Throop ave. from Halsey st. to Thornton st.	5,920
On Thornton st. from Throop ave. to Broadway	300
On Flushing ave. from Grand ave. to Washington ave.	750
On Graham ave. from Boerum st. to Van Cott ave	5,660
On Van Cott ave. from Graham ave. to Union ave.	1,500
On Manhattan ave. from Van Cott ave. to Newtown Creek	5,850
On Greenpoint ave. from Manhattan ave. to West st.	1,320
Total	53,885

or 10.2 miles, with a minimum capacity of 4,000 miles of wire.

The Citizens' Electric Illuminating Company and the Municipal Electric Light Company, which divide the city between them on the line of Flushing avenue and Broadway, reported (as an act of courtesy) December 1, 1888, a total of 130 miles of wire for both companies, of which 50 miles was attached to the elevated railway. The Citizens' Illuminating Company only has reported its operations for the present year, and according to its report, it has added about 18 miles of wire to the railway structure and has increased its pole lines to 120 miles. From the detailed survey of the Inspector of the board, a copy of which is annexed, it appears that the present mileage of the companies is as follows:

Citizens' Electric Illuminating Co.	215.4 miles.
Municipal Electric Light Co.	125.6 "
Total	341.0 "

of which the former company has 78.6 miles of "black" or good insulation, and 136.8 miles of "white" or poor insulation (so-called underwriters' wire), while the latter has 27.7 miles of "black" and 97.9 miles of "white." Unfortunately this board has no authority to control the installations of these companies, or interfere with their operations in any way, for the reason which has been stated in former reports, but which will now be stated again. The Act of June, 1885, makes it the duty of the board, in default of the proposal of plans by the electrical companies themselves, "to cause to be devised and made ready for use" an underground system, and compel all companies "to use such subway so prepared." But it does not furnish authority or means for the construction of such a subway, or means for the compulsion of companies.* And it makes even the choice of a system impossible, by annexing the condition that "it shall be the duty of the board in devising the aforesaid plan, so to devise the same that the subway may be used by any such city for the electric wires or conductors operated by its police, fire or other departments without expense, except the expense of the wires or conductors." This command to devise a common subway for all classes of conductors defeats its own object. The electric light wires should never be permitted in the same conduit with telegraph and telephone wires. What the board has hoped to do has been to find a system for a separate high tension subway which it could approve as feasible and safe, and then to obtain from the Legislature a release from the absurd condition it has imposed, and the means to compel the construction and use of such a subway, not by "all companies," but by such companies as ought to use it. This object not having been accomplished, the board was entirely powerless as regarded the electric light companies; for the act gave it no jurisdiction over aerial wires, until it should be prepared (in the impossible way just described) to compel them to be put underground.

By the letter of the counsel of the board, appended to this report, it will appear that the failure of the Legislature to provide for the continuance in any form of the powers of the board, leaves in force the Act of 1884, as amended by that of 1885; that there is now no power in any department to grant permits for overhead wires, and that it is still the duty of the city authorities to remove all such wires for which permits have not been granted with the approval of this board. While it is not suggested that the wholesale destruction of property should be entered upon by the city in obedience to the literal requirement of the law, it is believed that this situation, which puts the electric light companies in particular at the mercy of the city, may be fairly utilized to compel those companies to improve their methods and plant, and the report of the inspector of the board is appended for the purpose of indicating how great an improvement is possible.

In looking back upon the difficulties and labors of four years, the board is satisfied that as much has been accomplished as was practicable under the terms of the act, and it fairly claims the credit of having taken no step which it has been obliged to retrace—a result, whether due to wisdom or good fortune, which must be considered remarkable, in view of the uncertainties surrounding the problem attacked, and the hostile influences at work to hinder its solution.

A review of the policy pursued by the board, together with some suggestion based upon its study and experience of the subject, with regard to wiser legislation, may fitly conclude this report, and with it the service which the members of the board have to the best of their ability, and at some personal sacrifice, attempted to perform for the city of Brooklyn.

THE POLICY OF THE BOARD.

In view of the inconsistency, inadequacy and partial absurdity of the law, the question might be asked, how citizens with reputations to lose could consent to administer it? The notion that the acceptance of such an office implied the admission that its nominal duties were all practicable was not indeed entertained by the commissioners, but it was seriously doubted by them, at first, whether they could accomplish enough under the act to warrant them in undertaking the task. It was however urged upon them by the Mayor that the law, however defective, had been enacted in good faith, and would undoubtedly be amended as necessity should be shown; that its spirit was, to confer upon the board certain discretionary powers, in the exercise of which some public good might be secured; that it was better to do what could be done than to do nothing at all, while waiting for wiser legislation; and finally that if the board should receive from any electrical company within the 60 days prescribed by the law a practicable subway plan, the duties and powers of the board as to that company (and others capable of using that plan) would be clear and useful, even though its hands might still be tied by the law itself as against all other companies.

The board accordingly organized itself according to the law, and in due time the New York and New Jersey Telephone Company, operating nearly all the telephone wires within the city limits, presented with the concurrence of the Western Union Telegraph Company, a plan of subway construction which, after examination and some modifications, was approved by the board. If this plan had not been proposed, the commissioners could have accomplished nothing whatever under the act as it stood. The experience of the similar board in New York City confirms this opinion. That board receiving no plan from the electrical companies, tried to act under the alternative provisions of the law; and everything which it did was subsequently pronounced illegal; so that its work could only be rescued and continued by its reorganization with wider powers, and the legalization by special statute of its former acts. No such legislative assistance has been rendered to the Brooklyn Board. What it has modestly asked in that line has been invariably refused; and whatever it has accomplished has been done under the Act of 1885, with all its defects.

To understand the situation created by the proposal of the telephone and telegraph companies, it should be considered that there were in Brooklyn at that time (apart from the city wires) 4,659 miles of aerial conductors,* of which 4,600 miles carried low tension currents for telegraph or telephone; that of these 4,600 miles, 4,192 miles were owned or controlled by the companies agreeing to employ the proposed conduit; that 138 miles were owned by the Baltimore and Ohio Telegraph Company, which could use such a conduit; that 271 miles were owned by district telephone companies, carried upon house-tops, not upon poles, and not practicably to be combined in any conduit, while their extent remained so small and their distribution so scattered; and, finally, that the high tension electric light conductors amounted to but 59 miles in the whole city.

Obviously, therefore, the approval by the board of the system proposed by the telephone and telegraph companies would give it the right of inspection and control over nearly 99 per cent. of the existing electrical conductors; and if the problem presented by these could be successfully treated, *without hindering the future solution of the whole problem, comprising the disposition of all classes of electrical conductors*, the commissioners felt abundantly justified in attempting it. They anticipated (and in this anticipation they have not been disappointed) collisions with political and private interests, malicious misrepresentations and honest misunderstandings of their action; but they believed that they could accomplish for the city something worth doing, and not needing to be undone. The result has justified this belief.

In approving the box conduit of creosoted wood, described in former reports, the board had to consider, first, the practicability and safety of this system taken by itself; secondly, its relation to the public convenience, and to the desired reform of the nuisance of overhead wires; thirdly, its relation to the general problem, comprehending *all* electrical conductors.

Under the first head, the suitability of the material, ease and cheapness of construction, facility of laying and replacing or repairing conductors, and dangers from lightning or from gas-explosions, required examination.

Under the second head, the amount of disturbance to pavements involved in construction and maintenance; the extent to which poles and overhead wires could be superseded by the system; the degree of ease with which it could be progressively extended, without interrupting its operation; and the rapidity with which connections could be made or changed, received consideration.

Under the third head, the important question arose whether the adoption of this system would prevent the subsequent establishment of underground systems for high tension conductors.

At a number of public sessions, the board listened to the statements and examined the drawings and models of inventors, besides stuying in private the records of experience in other places. But neither at that nor at any subsequent time did it find reason to doubt the wisdom of its decision in favor of the box-conduit of creosoted wood, carrying lead-covered cables and connected with overhead terminal distributing system, for telephone and telegraph wires.

As to the material, it has proved entirely satisfactory, when properly prepared; and is superior in one or more particulars to any other that has been proposed. Of its great durability, there is no question. Its elasticity makes it better than any concrete or terra-cotta. It does not tear the lead upon the cables drawn into it, as both concrete and iron are likely to do; it permits a construction leaving no joints liable to sag and open by their own weight or under pressure.

As to the form, it is easily constructed and laid by ordinary workmen, permits the easy passage of cables, successfully resists all surface-pressures, presents a large capacity in moderate space, can be readily constructed to suit any capacity, and is in other respects as good as any form hitherto proposed.

Competitive trials of other materials and forms permitted by this board, and the use of such other conduits elsewhere, have not shown anything else to be better for the purpose named, and for the conditions existing in this city.

Furthermore—and this the board could not but regard as most fortunate—the system was not covered by patents and could therefore be freely used by all companies. If it had been radically defective in any particular, and any patented device presented to the board had offered a satisfactory and necessary remedy for such defect, the board would have felt bound to make its approval conditional upon the employment of the device. But this contingency did not arise; and with regard to its telegraph and telephone subways, Brooklyn is to-day not at the mercy of any patent, covering either material or form.

On the other hand, it was urged against this conduit by the advocates of other types, that it was not gas-tight or water-tight, and that it was not itself an insulator. These assertions are all true, but the conclusive answer is, that it is not practicable to make a subway perfectly and permanently tight, or practically insulating, and hence that money spent in that direction is thrown away. The protection and insulation of the conductors must be separately provided for; and for low-tension currents, this is satisfactorily done by enclosing the insulated wires in lead pipe.

Upon the subject of gas explosions the board, in its first report, made September 15, 1885, observed:

"The objection to box-conduits, that they may give opportunity for the accumulation of explosive mixtures through leakage from the gas-pipes, has been duly considered, and the board believes that effective provision can be made for the prevention of such accumulation in this conduit."

This provision was made and has proved effective. The frequent occurrence of such explosions in other cities has directed public attention to this source of danger, the elements of which are by no means absent in Brooklyn, and the significant absence of such occurrences in this city is directly due to the features of the Brooklyn subway system. Gas mains will leak. It is useless to forbid that; and to hold the gas companies responsible, as has been proposed, for the consequence of such leakage would be in many cases unjust, and would in all cases lead to intolerable public inconvenience in the perpetual disturbance of the streets for repairs. Especially when, by the reckless inclusion of gas main joints in a conduit or manhole of later construction, the leakage has been invited, the responsibility of its consequences can scarcely be upon the company which laid the main originally in a proper way, and did not provide for its subsequent exposure and the suspension of the joint in air, or its subjection to variations of temperature.

In many instances, the serious explosions in subway manholes have been traced to such exposed and strained joints, improperly included in the subway system. Against the rush of gas from such a large leak, perhaps no artificial ventilation would be an adequate protection. The obvious remedy for such a danger is to have no gas main joints included in the subway excavations.

But apart from this preventable peril, the soil under all streets where gas mains have existed for any considerable period is more or less saturated with gas, which may find its way into any adjoining spaces. This consideration should prevent the direct connection of open subways with the cellars of buildings. On sanitary grounds alone, such a connection is to be condemned. If house-connections are underground, they should not be made through pipes or open conduits.

Another objection to such connections is that they interfere with the proper ventilation of the subways. A building 60 feet or more in height, and often filled with warm air, will counteract any puny, cheap chimney that may be set up to oppose its action.

In Philadelphia, and to some extent in New York, when the so-called Johnstone system of underground house connections has been tried, explosions have occurred which were plausibly ascribed to intentional or accidental lighting of accumulated gas in the cellars. Since this system has been loudly advocated as a "complete solution of the problem," it may be well to add that the board, after careful examination of it, including a special report by a competent expert, considers it to be unsafe as to house connections, and adheres to its original conclusion, that such connections should be aerial, unless they are so permanent that they can be made, once for all, perfectly safe (by solid filling or otherwise) against the entrance of noxious or inflammable gases into the houses.

It is probably because of these house connections, open or liable to be open, that the natural ventilation of the subways, as practiced in Brooklyn, has not been resorted to in other places. At least, this is the only reasonable explanation of such an omission. For the experience of colliery engineers with inflammable hydro-carbons and their explosive mixtures with air proves that such gases, by reason of their lower specific gravity, tend to hug the roofs of all confined spaces, and to escape by all upward vents, and that they mingle but gradually with the heavier air; so that, if not left alone too long, or entering suddenly in too large a volume, they can be drawn off.

The comparatively small amount of gas ordinarily entering a subway can be thus removed by simply ventilating it, particularly at manholes and at saddles or grade summits, through pipes or boxes extending to a sufficient height. In the Brooklyn system, these ventilators often serve also as ducts to the distributing points on the house tops or poles. Thus, from the manholes near the elevated railways, three-inch iron pipes both act as ventilators and carry the cables to and up the railway columns. A cable carried from the subway up a pole or the side of a house for the terminal distribution of its constituent wires is enclosed in a box, which thus ventilates the subway. Special ventilators are also employed when needed.

The attempt to ventilate conduits by means of fans is not a good substitute for the natural system. As mining engineers are well aware, suction fans are better than blowers, where fans are required. For the suction will draw out the dangerous gases while blowing may merely bank them up, and by forcing air into them, convert what was previously only inflammable into a dangerously explosive compound. But suction fans have failed in their application to subways, for the reported reason that they draw into the conduits additional gas, increasing the leakage in proportion as they diminish the interior pressure below that of the atmosphere. Hence, the usual practice is to blow air into the conduit, and hope that it will blow the gas out, a neighboring manhole being generally opened for the escape. This, it is confessed, whenever there are house connections open or leaky, will force gas into the cellars; and the mixture of gas and air thus produced will be explosive. On the whole, therefore, this board is entirely content to have succeeded in avoiding the conditions requiring such desperate remedies. If fans are used on the Brooklyn subways (as they may be for

* The board is not made by the act capable of suing or being sued—a defect which, though overlooked in cases in which the board has appeared as defendant, would have proved fatal if it had proceeded as plaintiff. The attempt of the board to have it cured by additional legislation was defeated.

* The law does not require a company constructing its own system upon its own plan to leave room in it for city wires; but this was done voluntarily by the telephone company at the suggestion of the board. The board, however, has had no power to oblige the city to use such conduits; and the police and fire departments prefer in most cases to construct separate subways.

The statement compiled for June, 1886, when the work of putting conductors underground practically began, is here followed, fractions being disregarded.

special and temporary purposes, such as clearing out a manhole for the comfortable entrance of workmen, by removing not merely the light inflammable gases, but the heavy carbonic acid which may collect in underground spaces), they will blow neither poisonous nor explosive mixtures into stores and dwellings. And so long as the system adopted by the board shall be intelligently maintained, our citizens need not fear, as the latest result of scientific enterprise, the sudden and inexplicable uprising of pavements and sidewalks, in exchange for the previous perils of wires and poles.

Under the head of the public convenience, the board rejected "solid conduits," as involving, except when installations are permanent, an intolerable frequency of excavation, and as not permitting, without such excavation, the change and repair of conductors. Since good pavements are all important, and no pavement (except perhaps, an asphalt one) can be good if it is repeatedly broken and partially relaid, this consideration should be absolutely conclusive. The board, moreover, by adopting a subway in which conductors could be conveniently changed at will, was enabled to lay upon the electrical companies the entire burden of the purely electrical problem. But one requirement was made of the companies in this direction, namely, that they must be prepared to use metallic instead of grounded circuits (that is, to use at least twice as much copper for the same amount of service) if that should be found necessary to the successful operation of the new system. It was found necessary, and for a large part of the telephone system it has been done. The size of the copper conductors, and consequently of the cables, has also been increased, and this has required a trifling increase in the original size of the conduit-ducts. Otherwise, the whole system is operating to-day with perfect success on the lines originally laid down, and the board has not been obliged to retrace any step once taken.

At one time there existed serious apprehension that this satisfactory record might be broken. The corrosion of the lead covering of the cables in the subway was strongly asserted to be due to the creosoted wood; and one concern employed in the manufacture of such cables declined to guarantee them if laid in such a conduit. It was found that alloying the lead with about four per cent. of tin would prevent serious corrosion; but this rendered the metal somewhat harder to work as well as more expensive. A fibrous covering over the cable was also reported to be a sufficient protection; but this, in the opinion of the board, though not seriously objectionable, might either cause difficulty or receive injury during the drawing of the cable into the the subway. The telephone company in Brooklyn, manufacturing for the most part its own cables, preferred the tin alloy; and the Board, satisfied that the creosoted conduit, so excellent in other respects, need not be condemned on this account, continued to approve its extension, while studying carefully the symptoms and causes of the corrosion of the cables.

The product of the corrosion appeared to be lead carbonate, and this pointed to carbonic acid gas as the active agent. This gas being present in illuminating gas, and especially in that made by the modern method from "water gas," it was natural at first to ascribe the corrosion to its action, and cases reported to the Board in which cables laid in iron or concrete ducts had been corroded seemed to confirm this view. On the other hand, naked lead pipes laid in the soil are not specially subject to corrosion, except when they are exposed also to organic acids; nor does carbonic acid act with great vigor upon metallic lead at ordinary temperatures. Experiments in the laboratory show a slight coating to be produced by long exposure to currents of the illuminating gas used in Brooklyn, but not such as to fully account for the destructive effects observed in several instances in the subway. It was further noted that different parts of the subway exhibited different degrees of corrosion, even upon cables of similar constitution; and the conclusion was finally indicated that some variable (and therefore probably volatile) constituent in the creosoted wood initiated and intensified the action of the carbonic acid. A series of careful analyses performed for the board by Prof. Richardson, the head of the laboratory of the Cooper Union, proved this constituent to be phenol, which, being highly volatile, either escapes from the wood in the process of seasoning, or could be expelled more rapidly, if required, by artificial means. Several observed cases indicate that the creosoted wood loses after a time the tendency to promote corrosion; and the analyses of the corroded material show that the phenolate of lead is a main ingredient. The board is therefore inclined to the opinion that the removal of the phenol, by time or otherwise, from the creosoted wood will prove a remedy for the evil of corrosion, perhaps rendering any other remedy unnecessary.

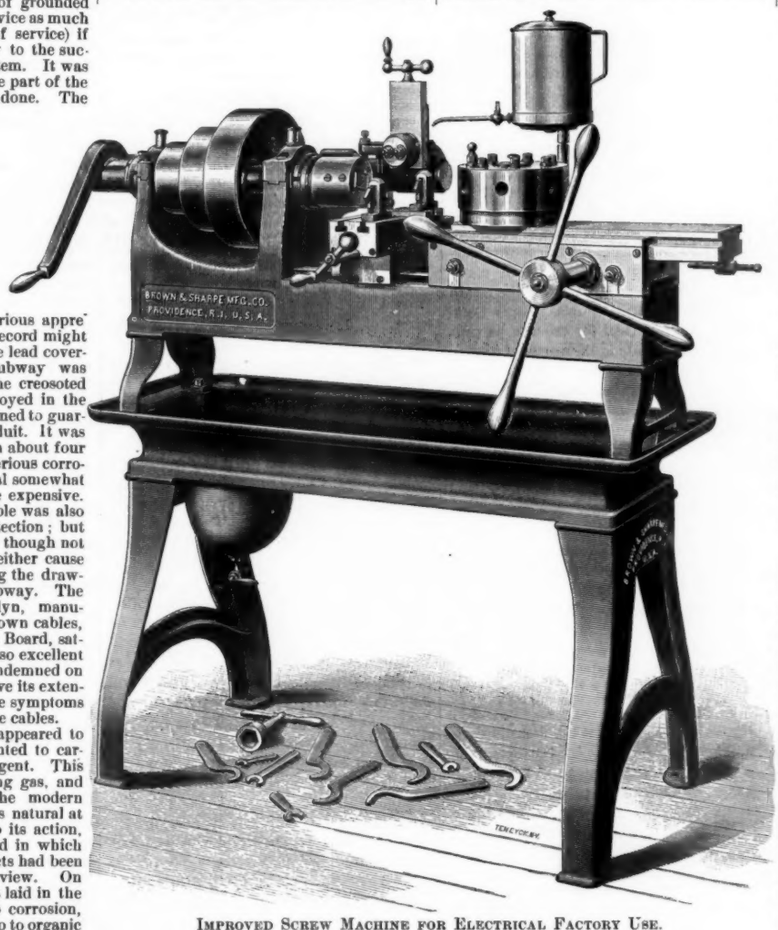
It remains to state the considerations actuating the choice of this system in its relations to future and more comprehensive ones. The board was naturally unwilling, by the adoption of any partial and temporary expedient, to forestall some better arrangement; but any apprehension of this kind was removed by a careful study of the problem.

This problem is primarily municipal rather than scientific. In the rapid extension of the acknowledged benefits of electrical distribution, large cities have been brought into contact with serious evils, which it was the primary purpose of legislation upon the subject to remove. These evils are:

(*a*) The nuisance of poles and overhead wires disfiguring the streets and buildings and interfering with the work of firemen. This evil is real and great.

(*b*) The dangers of such poles and wires may be classified under three heads: Danger of injury caused by their fall; of fire, caused by their incandescence; and of death, caused by the passage of the electric current through men or animals. The first of them may be disregarded. Authentic instances of such casualties are exceedingly rare. The second is peculiar to "quantity" currents, usually of low tension, and affects especially the interior of buildings in which incandescent lights are used, though it may be caused also by the escape of electrical currents from their proper conductors, to conductors too small or too highly resisting to convey the currents without great rise in temperature. Thus the current from an electric light wire, entering a house upon a telephone wire, will burn out the interior coil of the telephone instrument, and may thus set fire to the house. The third danger originates with the high tension conductors, but affects all wires whatever, with which these may come into electrical contact, or to which their powerful currents may leap. No wire, however harmless in itself, or however harmless the purpose for which it is intended, can be safe while there is a chance that it may form a connection for some destructive current communicated to it by another wire. In fact, the telephone and telegraph wires, entirely harmless by themselves, are in this respect the most dangerous of all, because they are naked, while the high tension conductors are more or less completely insulated. Such a high tension conductor, for instance, though completely insulated at

(*Continued on page 6.*)



IMPROVED SCREW MACHINE FOR ELECTRICAL FACTORY USE.

Screw Machinery.

The demand in electrical manufacturing circles for fine machinery is constantly increasing, and the manufacturers of machinery of the style illustrated in this issue have promptly realized that progress is as necessary in the field as in all others. The machine illustrated is from the large shops of the Brown & Sharpe Manufacturing Company, Providence, and is suitable for making from bar iron or steel, all kinds of screws and studs, ordinarily used in a machine shop, also for drilling, tapping and facing nuts and for finishing from the rough bar or from forgings or castings, gas and steam fittings, and parts of sewing machines, cotton machinery, etc.

A lever, to be used in operating the cutting off slide in place of the screw shown in cut, is furnished when desired. The turret head is secured in position by a simple and durable device.

The details of this machine are as follows: The spindle boxes, $2\frac{3}{4}$ inches and $2\frac{1}{4}$ inches in diameter, and $3\frac{7}{8}$ inches and $2\frac{7}{8}$ inches long, are steel, hardened and ground inside and out. The spindle is also steel; its front bearing is hardened and both bearings are ground. The spindle cone has three grades, 6 inches, $8\frac{1}{2}$ inches and 11 inches diameter for $3\frac{1}{2}$ inch belts. Size of hole through spindle, $1\frac{3}{16}$ inches; number of holes in revolving head, 7; diameter of these, $1\frac{1}{8}$ inches; movement of revolving head slide, $9\frac{5}{8}$ inches; distance from top of slide to center of holes in revolving head, $2\frac{3}{4}$ inches; greatest distance attainable between revolving head and front of chuck, $16\frac{1}{2}$ inches; length that can be milled, 6 inches; swing over slide, $6\frac{1}{4}$ inches; swing over bed, $13\frac{3}{8}$ inches; length of bed, 50 inches. Countershaft has friction pulleys 14 inches in diameter, $3\frac{1}{2}$ inches face and should run 190 turns per minute. Weight, ready for shipment, 1,450 lbs. Floor space, 32x62 inches.

Spokane Falls, Wash.—A new telephone company has been established, which will have its headquarters in Spokane. Mr. W. S. Norman is the manager.

Lake Charles, La.—A company has been organized with a capital stock of $25,000 to put in electric lights and water-works. G. W. Randall, of Brownsville, Tex., is interested.

Paris, Ky—The Paris Electric Light Company has been organized with a capital stock of $60,000.

Milwaukee, Wis.—The Milwaukee Electric Railway Company; capital, $500,000; incorporators, J. A. Hinsey, H. H. Field and D. Atwood.

New Iberia, La.—The New Iberia Electric Light Company has been organized here, with a capital stock of $10,000. President, J. A. Breaux; secretary, W. M. Gates.

St. Helens, Md.—The St. Helens Telephone Company has been incorporated by C. B. Lowry, S. P. Stamper and J. M. Sharpe to construct a telephone line from St. Helens to Beattyville.

Burnham, Tex.—A stock company is being organized to erect the ice factory and cold storage plant. Adolphus Busch and associates, of St. Louis, Mo., are at the head. An electric plant will also be erected.

East St. Louis, Ill.—The Electric Holder Company; location, East St. Louis; to manufacture and deal in electric holders; capital stock, $50,000; incorporators, F. C. Hoyt, A. H. Bacon and C. D. Kelley.

Denison, Tex.—The Denison Light and Power Company, of Denison, has been incorporated with a capital stock of $125,000, to erect an electric light plant. J. B. McDougall, John Scullin, G. R. Madill, W. B. Munson and others, incorporators.

East St. Louis, Ill.—The Atwood Electric Company, of East St. Louis, is incorporated. Capital stock, $500,000. L. C. Atwood, E. B. Roth, and C. C. Weaver, are the incorporators. The purposes of the company is to supply light, heat and power, and will commence operations at once.

Portland, Me.—The Bell Rock Electrical Conductor Company has been organized in Portland, for the purpose of manufacturing and dealing in insulating materials and all kinds of electrical goods. Following are the officers: President, Adam Cook, Malden; treasurer, Peter B. Willey, Wakefield. Capital stock, $500,000; paid in $500,000; par value of shares, $100.

Topeka, Kan.—The electric railway, light and power company, of Topeka, has been incorporated, and filed its charter with the Secretary of State. The company is formed to build the electric railway heretofore mentioned in the REVIEW. The capital stock of the company is $150,000. The officers and directors are W. E. Sterne, president; D. C. Metsker, secretary, treasurer and manager; R. R. Moore, A. B. Wolverton and D. O. McCray.

Harrisburg, Pa.—Articles of incorporation have been filed with the governor for the Chartiers Valley Electric Light Company, capital stock $3,000. The directors of the new company are Percy F. Smith, W. A. Zahn, Wm. Macrum, J. J. McCormick and George Glass. Mr. Zahn is president, Mr. Glass secretary and Mr. McCormick treasurer. The company intends to supply the residents of Idlewood, Crafton, Ingram and vicinity with electric light.

Brooklyn, N. Y.—A certificate of incorporation of the Kings County Gas and Illuminating Company was filed in the County Clerk's office. The capital stock is $100,000, divided into 100 shares, and the corporators are Charles C. Burns, of New York; James K. O. Sherwood, of Glen Cove, Queens County, and Alfred N. Hebre, of Hollis, Queens County. The company's principal office will be at New Utrecht and it will carry on business in Brooklyn and the county towns. It will manufacture and supply and sell gas and electricity, or either, for the lighting of streets, roads, public parks and places and public and private dwellings.

ELECTRICAL REVIEW

Published at 1,3 Park Row
P. O. BOX 3329.

GEO. WORTHINGTON, - - Editor.
CHARLES W. PRICE, - Associate Editor.
T. J. McTIGHE, Electrician and Manager Patent Bureau.

REGISTERED CABLE ADDRESS:
"ELECTVIEW," NEW YORK.

"546 JOHN," TELEPHONE CALL.

BOSTON OFFICE:
STEPHEN L. COLES, 196 Summer St.

WASHINGTON OFFICE:
GEO. C. MAYNARD, 1419 New York Ave.

CHICAGO OFFICE:
D. B. DEAN, 61 Metropolitan Block.

EUROPEAN OFFICE:
CHARLES FFRENCH, Bridge House, 181 Queen Victoria St., London, E. C.

SUBSCRIPTION TO THE ELECTRICAL REVIEW.

One Year, United States and Canada, - $3.00
One Year, Foreign Countries, - - 5.00
Single Copy. - - - - .10

ANNOUNCEMENT.

Address all communications and make all money orders and checks payable to order of ELECTRICAL REVIEW, P. O. Box 3329, New York.

No attention will be paid to communications for the REVIEW without the *name and address of the writer.*

NEW YORK, JAN. 4, 1890.

CONTENTS.

	PAGE.
Electric Air-Line Transportation	1
The Brooklyn Subways	1
Screw Machinery	3
New Corporations	3
Kemmler to be Executed by Electricity	4
Napoleonic Methods Increasing in Popularity	4
The Double Carbon Patent	4
The Brooklyn Report	4
New York's Government	4
Electrical News:	
Our Boston Letter	5
Our St. Louis Letter	5
Our London Letter	5
The Multiplex Telephone System	5
Personal	5
To the Kansas City Convention	5
An Electric Soldering Rod	5
Telephonic News	6
The Autocrat of the Telephone	6
Electrical Letter Stamp	6
A Good Chance	6
To Change the Patent Law	6
Another State Organizes	9
New Heavy Double Braiding Machine for Covering Cables and the Larger Sizes of Wires	9
Who Will Answer This?	9
Electric Light News	9
Electric Power	10
An Electric Elevator Installation	10
Cleveland's Electric Cars	10
Test of the Sprague Motor at Reading, Pa	10
In Favor of Brush	10
Kindred Interests	12
Water and Oil Separator	12
Electric Lighting in Oregon	12
Train Lighting	12
Electric Light Superintendent Indicted	12
A New and Complete Electric Light Station	13
Electricity vs. Gas	13
Give Us More Light	13
Pocket Magneto Testing Bell	13
A Sensible Conclusion	13
The Southern New England Telephone Company—New Metallic Service	13
Telegraph News	13
Prof. Phonograph	13
Hard on the Pass User	13
Electrical Patents	13

Why does not somebody start a school for the instruction of young men in such practical knowledge as is required in constructing and operating electric plants. Large numbers of persons who would, with fair opportunity, become perfectly competent for such work cannot have the advantage of a college course and, even if they gain an opportunity of learning the business in some electric factory, they are most likely to learn only one system (or a small part of one system) and get a prejudice against all others. A station well fitted with a variety of engines, dynamos, and other suitable appliances; a few good instructors in theory and practice; some means of utilizing the surplus "energy," and the candidates for positions as electric artisans would be forthcoming.

Those who expect to be present at the Kansas City Convention of the National Electric Light Association, will be pleased to learn that Prof. Elihu Thomson will address the convention on the subject of "Safety Devices in Electrical Installations." This is an important subject and is in the hands of a most competent man.

The first indictment against an officer of an electric light company, for causing death by electricity, has been presented by the Grand Jury of this city. It is against Chas. W. Pierce, superintendent of the Brush Electric Illuminating Company, an account of which appears in another column. The peculiar wording of the indictment will strike every one who reads it.

The Empire State should not be behind in the matter of forming a State Association of electric lighting interests. Chairman E. W. Maher, of Albany, is a gentleman of ability and discretion (as well as one of good looks), and we expect to hear from him at an early day that a State Association has been formed. The situation in New York City, and the very natural influence it will have on other cities, we think demand that a strong and comprehensive State Association be formed without delay.

The press of New York City, which a few weeks ago was devoting all its departments, reportorial, editorial, sporting, social, humorous (alleged), etc., to giving reasons for the cutting down of electric wires in this city, has suddenly become much more reasonable, and with an agility that is very suggestive, faces about, and is now, in many instances, attacking Mayor Grant, the Board of Electrical Control, Public Works Commissioner Gilroy, etc., for the conspicuous blunders being made in the matter of cutting down the wires and plunging the city in darkness. We are inclined to think that this sudden change is brought about by the fact that they have discovered that the citizens of this community are not with them. Merchants found they could not do business without the electric light, stopped their advertising, and have been flooding the daily papers with complaints of the situation, which they and every one else who cares to give the matter any consideration, knows is one that ordinary discretion on the part of the responsible officials could have prevented.

KEMMLER TO BE EXECUTED BY ELECTRICITY.

The order dismissing the writ of *habeas corpus* in the Kemmler case has been affirmed. Kemmler was the first murderer condemned to death under the new State law providing for execution of criminals by electricity.

Judge Dwight, in giving the opinion in the General Term, at Rochester, last Monday, says that the death punishment under the new law is unusual, but it is not cruel.

NAPOLEONIC METHODS DECREASING IN POPULARITY.

The New York *Sun* remarks editorially:

"The Mayor, with all his praiseworthy intentions, seems to us, therefore, to have proceeded without good judgment. It struck many of the people and the newspapers pretty generally as an admirable and Napoleonic way of doing things to send men out at short notice to tear away the wires as the police might be thrown against a raging mob. But such a summary method of doing the job has proved in practice to be mischievous. It has seriously disturbed the comfort of many thousands of citizens and *lessened the safety of life and property.*"

We supply the emphasis in the last line and publish the paragraph as a sample of the present newspaper utterances, now that they are about through with admiring the "Napoleonic way of doing things."

Says the intelligent *Mail and Express*:

"The electric light has become a necessity. We must have it. It insures safety to persons, it protects property, re-enforces the police, helps merchants to sell their goods, guides footfarers over otherwise dangerous places. We cannot and must not be compelled to do without it. For darkness to reign in our streets for another month would be disgraceful. Let us have light!"

THE DOUBLE CARBON PATENT.

Mr. Chas. F. Brush, Cleveland, is to be congratulated over the decision which has just been rendered by Judge Gresham in the United States Circuit Court, broadly sustaining his double carbon lamp patent. The Brush Company had brought suit against the Fort Wayne Electric Company, on this patent, and the decision in the case was announced December 24th at Indianapolis. We publish it in full.

The Brush Company is convinced that this will give them complete control of all-night arc lighting. The decision coming at the present time puts an interesting phase on the arc lighting question.

It is generally understood that control of the Brush Company has been purchased by the Thomson-Houston Company, of Boston. It is known that the Fort Wayne Company is allied with the Thomson-Houston Company. Therefore, this decision, while vindicating Mr. Brush, is really of more value to the Fort Wayne Electric Company than it would have been had the said company won the suit, for now the Brush patent having been declared valid, the allied interests above mentioned can work under it and present a strong front against their opponents.

THE BROOKLYN REPORT.

We publish in full the report of the Subway Commissioners, of Brooklyn, which is an interesting and comprehensive review of the work done in that city. The report contains a number of valuable suggestions, the result of experiment and investigation on the part of the Commissioners both in this country and abroad. It is shown that there is a total length of conductors now underground in Brooklyn, apart from the city wires, of 3,070 miles and on the elevated railroad, apart from the electric light wires, 768 miles, and that the average thus removed from poles and housetops is larger than the total telephone and telegraph wires which were existing in that city in 1885 when the Board was organized.

We think that when the many embarrassments under which this Board has labored are considered and the electrical situation of Brooklyn noted, the Commission is to be congratulated and its work highly commended. Much praise should be given, we think, to the prompt manner in which the N. Y. and N. J. Telephone Co., under the intelligent guidance of General Manager W. D. Sargent, aided in the work.

Everyone interested in the problem of "What shall be done with the wires?" will find this final report of interest and value, and should give it careful and thoughtful perusal.

It is not necessary to compare Brooklyn with New York. The latter city is disgraced enough. She has returned to the primitive days of gas and oil. She has become the laughing stock of the world. She can look across the bridge and see a beautifully lighted city, where in the case of the subway board intelligent and fit men were appointed to office.

The attorney of the Brooklyn Subway Board says telegraph and telephone companies have charter rights as carriers of public messages that electric light companies do not have. This is a point we do not remember to have seen considered.

Co-operative telephone companies are proposed in England as soon as the Bell patents expire. A "competent engineer" estimates that an investment of £12 per subscriber in an exchange of 1,500 would be sufficient capital to start the company, and on this basis figures handsome profits. He ought to, for leaving out the question of royalties it will take almost four times that sum per subscriber to successfully establish an exchange of that size, with multiple switchboards, metallic underground circuits, strong current protectors, magneto bells, etc. But such figures will be believed by the general public, and many will invest expecting to receive great profits and then be compelled to increase the investment four fold or lose all.

NEW YORK'S GOVERNMENT.

New York seems to be the worst governed city in this country. One is led to ask, is there a single department wherein the real and best interests of the people are consistently looked after to the complete exclusion of individual benefits? Or is it not rather the fact that every department has the taint of political bossism so saturated into it that the people and the people's rights are sunk out of sight in the abominable corruption and greed that characterize our system? Undoubtedly. The law making power of the legislature has been debauched, individual rights trampled upon, and all the chicanery of enforced situations invoked to give semblance of right to the strong arm of the law.

The subway law was passed and a Board of Electrical Control appointed. Protegees of the bosses needed jobs and they got them. Square plugs were put in round holes; but no matter, the plugs had to be put somewhere. This board was then made up of item one, politician; item one, theater proprietor; item one, young lawyer; with not a single item of electrical knowledge among them all. They didn't even know the merest rudiments, and it was said of one of them that he asked an expert if a battery pole was anything like a telegraph pole! They were, however, given almost supreme control of the great vested rights of the lighting companies, whose millions of dollars worth of property lay almost at their mercy. Rules were formulated without any sense because founded on ignorance, but the companies had to follow them. The board had no electrical knowledge, but what of that? They could be educated!

And what is the result at the end of this never-to-be-forgotten year? A year ago the best lighted city in the world; to-day, not even a decent rival to a country village. A year ago studded everywhere with the lights of which the Chief of Police said: "Every one of them is as good as a policeman"; to-day, darkness and shadows and crime. Lights all out, hundreds of thousands of dollars worth of property destroyed and made useless on the plea of nuisance.

And what alternative has this omniscient board given us? A few subways for trunk wires, manholes at intersections of streets, and no provision for house-to-house distribution. Subways which are or will prove inadequate and worthless by and by, and which are much more dangerous to life and property than the overhead system. The latter system could have been made entirely safe under the management of a board constituted of men of practical electrical knowledge and experience. Already these subways are showing the power for evil they possess. They invite a gathering of all the leakage gas from rotten and defective gas mains. The gas and air mingle in the manholes and become a highly explosive mixture, needing only a spark, and then up goes the street and anybody who may be at the spot at the moment. There is no mystery about it, but there is plenty of danger, and the danger will never be less until that other nuisance of leaky gas mains is effectually abated.

But these hidden, inaccessible underground wires will be a far more potent cause of trouble than ever would be the *properly controlled* overhead system. It would have in the end cost no more to construct open subways large enough to permit thorough inspection of all wires therein at every foot of their length—but then there were no patents on such a structure and no side emoluments in the scheme.

Meanwhile the electric light and telephone companies and the poor citizen have to foot all the bills—the salaries of a board of nincompoops, the wages of an army of destroyers, the cost of thousands of new gas lamps, and, if we are not mistaken, the city will pay the heaviest bill of damages it has ever been the lot of a municipality to pay. But then think of the lot of nice smooth round horizontal holes we have under some of our streets. It is not every city that has such a unique plaything for the taxpayers to fondle and gloat over.

ELECTRICAL NEWS.

What is Transpiring in Electrical Circles in the Leading Cities.

OUR BOSTON LETTER.

Natick.—The electric light company is putting in two large dynamos, and the Natick Gas Light Company announces its intention of selling gas after January 1st for $1.90 per 1,000 feet, which is quite a reduction from the former price of $4 per 1,000 feet.

Springfield.—The aldermen have unanimously voted to grant the street railway company permission to operate the line from State street to Forest Park by the single trolley system. It was further voted that the company bind itself to the city to cut its wires in all cases of fire and repair the same at their own expense, and also to hold the city harmless for all damages resulting to telegraph and electric light wires or to persons or property of whatsoever name and nature. The railway company will at once enter upon putting in the plant and the extending of its tracks from Mill River to the Park.

"**La Grippe**" has asserted itself with special fury among the West End Company's employés. About 300 drivers and conductors are affected, beside many among the office force. This will delay the changes in running new lines and rearrangement of some of the old ones which it was proposed to make within a few days.

Lowell —The high wind of last Thursday afternoon blew down the heavy branch of a tree on Gorham street, opposite the court house. The branch struck the electric wires and they caught on top of a passing street car, the force being sufficient to pull down a pole, also breaking the telephone wires. The linemen adjusted the difficulty as soon as possible, but there was some delay to travel.

After many hearings and long months of waiting, the board of aldermen has granted permission to the Lowell and Dracut and the Lowell Street Railway Companies to erect poles, string wires and use the single trolley or storage battery system of propelling cars. It is provided that wires of the police, fire alarm or other companies where they are liable to come in contact with the overhead wires of the railway company shall be protected by two guard wires. The feed wires are to be placed underground and shall be insulated when the board of aldermen orders the same. It is also provided that the officers and members of the fire department, in case of the interference of the wires at a fire, shall have authority to cut them and they shall be repaired at the expense of the railway company.

Thomson-Houston Electric Co.—The stockholders of the company held a special meeting this week, when it was unanimously voted to increase the preferred stock from $1,000,000 to $4,000,000. Seven per cent. will be the rate of dividend on the new stock.

Mr. R. T. White, of No. 12 Pearl street, Boston, has issued a handy calendar, advertising the merits of his appliances for street railway construction. The "Daisy Chair" receives a prominent place. S. L. C.

Boston, Dec. 30, 1889.

OUR ST. LOUIS LETTER.

Street Signs.—A puzzle in the form of street signs is troubling President Flad of the Board of Public Improvements. Formerly the names of the streets were painted on the glass panes of the street lamps, but this is impracticable in reference to the arc light. It has been proposed to throw the name of the street on to adjoining houses by means of the electric lamp; but as many corners are not equipped with lamps it is hardly possible. The latest device is that of a sign consisting of a brass stencil, having the name of the street cut in it, and the side bent over to allow the slipping in of a ground glass plate. 16,000 of these will be required, if adopted, at an expense of $8,000.

De Sotto, Mo., is being agitated with an electrical complication in respect to the city's lighting. Two years ago an exclusive franchise for 15 years was offered by the City Council to whosoever would first erect an electric plant for supplying the public at large. Messrs. Pecant & Racine were the first to accept it, and built an Edison plant. Lately the question of lighting the city by electricity was brought up. Pecant & Racine made a bid of $200 per month for 100 thirty-two candle arc lights, intending to increase their plant's capacity to 3,500 lights and by the commercial circuit redeem the loss on their city contract. Other companies, wishing to gain a foot-hold in the city, have offered to fill the contract at a much smaller price. These bids, the city now finds, it cannot accept, owing to the franchise granted Pecant & Racine; and the Council is now in a quandary how to surmount the monopoly the Pecant & Racine Company has over it.

Fire.—The Guernsey-Scudder Electric Light Company was burnt out on the 20th. The station was totally destroyed, but carried full insurance. The company has secured the electric plant at the Exposition Building, with which they will continue their service until their own plant can be rebuilt.

The Officers of the recently incorporated Southwestern Electrical Engineering Company, are as follows: C. J. Bruner, president and manager; C. R. Weston, secretary; A. Irvine, superintendent.

The Missouri Electric Light Co. has now 20,000 lights in operation, and has contracts for 5,000 more for the 1st of January, including the 1,000 lights for city use.

Electric Railway.—Mr. John Scullin expects to receive a franchise for an electric railway shortly, and will have his street railway running by the middle of February by electricity. Thirty motor cars have been ordered. The system will be the overhead wire of the Thomson-Houston. A number of steel poles of handsome workmanship will supersede the wooden poles commonly used, and will be received as a vast improvement.

Personal.—Mr. Fred H. Whipple, who filled the position of superintendent of the Electrical Department of the St. Louis Exposition, has been retained in that position. It has been decided to bring out more prominently this feature of the Exposition; and in the display for 1890, three gold medals will be awarded—one for the best incandescent light plant, one for the best and most novel electrical display, and one for the best arc light plant. Gold and silver medals will also be given for various electrical features, as inventions, etc.—Mr. H. A. Irwin, of Bloomfield, Ill., is visiting the city. Mr. Irwin is general manager of the street railway lines of his city, and is here to examine the electrical roads now in construction. The Bloomfield electric line is at present being built, and the change from horse-power to electricity will be made about January 10th. Its length will be some three miles.

Telephone Conduit.—The Bell Telephone Company has presented a bill to the City Council asking for the right to construct a conduit on the main business streets. The Dorsett Subway and the Municipal Electric Light Company already enjoy unrestricted rights to use the streets for electric wire conduits, and it is suggested that the Bell telephone people use alleys instead of streets. With this amendment the bill will probably pass. The Bell Telephone Company is erecting a handsome building on Tenth and Olive streets. It occupies a central business location, and is well fitted for a telephone station.

SUBURBAN NEWS.

St. Charles, Mo.—The electric light committee received bids on Wednesday, December 11th, for supplying the city with an electric light plant. The lowest bid was $14,800. There was but one bid to furnish the city with electric lights by contract.

Litchfield, Ill.—The Electric Light and Power Company, of Litchfield, has decided to increase its power by a 100 horse-power engine and its capacity with a second 50 arc light dynamo.

Taylorville, Ill.—A meeting was held by the Taylorville Electric Light Company for the election of officers. W. W. Anderson was chosen president and J. N. Shumway was elected secretary. The capital stock of the company is $15,000.

East St. Louis, Ill.—Three bills were brought up in the City Council at its meeting on Dec. 11th, asking for the right of way for three electric roads. One is to be operated between New Brighton, Ill., and East St. Louis; another is to run from Belleville, Ill., and this city, while a third asks for an extension of the St. Louis & East St. Louis Railway, now operating on the St. Louis Bridge, to the National Stock Yards, a distance of two miles on the *East* side. Mr. J. T. McCasland and Mr. D. B. Alexander, the promoters, respectively, of the first two bills, have already obtained a franchise from the towns of New Brighton and Belleville, and are only waiting for the action of the City Council before they begin the construction of the two electric lines. Mayor Stephens and Alderman Marsh have been examining the street-car system of Alton, Ill. The cars of that city are run by a dummy motor and give perfect satisfaction. It is for comparison with electricity that this examination is made, it being a project of East St. Louis to connect Alton and itself by dummy or electric motor lines.

St. Louis, Dec. 26th. W. H. B.

OUR LONDON LETTER.

The London County Council at their meetings last week appointed Mr. G. Clement Dunscombe, the city engineer of Liverpool, to be their engineer at an annual salary of £1,500. The election of Mr. Dunscombe is undeniably a good one. For the last few months there has been an extraordinary rise in the price of india rubber, and the market value is now double what it was twelve months ago. The stock on hand is very limited, and there is a continual falling off in supply.

Electric Copper Deposition.—The launching of the Elmore process for the deposition of copper by electricity has been attended with phenomenal success. Among those who applied for shares were some of our best known electricians, and in the last fortnight the £2 shares have risen to double the price. The company have had works specially built near Leeds, and operations are to begin next week when some of the first productions in wires and tubes will be submitted to the Board of Trade authorities.

Messrs. John Barker & Company, who have followed in the path of William Whiteley at Bayswater, and have made themselves universal providers to Kensington, issued a large number of invitations last week to view their new premises in High street, Kensington. The place is to be lighted throughout by electricity, current being obtained from the Kensington and Knightesbridge Electric Light Company, and a great deal has already been done in that direction. The installation has been carried out by Messrs. W. T. Goolden & Company, the principal floors being lighted by 42 Alpha arc lamps from the Planet Engineering Company, while in the windows and upstairs Sunbeam lamps are employed.

France at Edinburgh.—I am informed that France will be well represented at the Edinburgh Electrical Exhibition, the French Government having undertaken the transport of all goods and exhibits, both going and on return. From France and Belgium about 120 electrical exhibits are expected.

The Duke of Argyll's residence, Inverary Castle, is to be lighted throughout by electricity.

Mustard oil is now being made use of as a lubricant and, it is said, with great success in Germany. It is claimed to be neither susceptible to cold nor to easily form the acids which attack and injure metals. Of its lubricating properties, Professor G. Herman, of Aix la Chapelle, speaks most highly, but does not give particulars as to price, etc.

The electric light is now used throughout in the great Paris market.

Mr. J. S. Hayden, of the Bridgeport Copper Company, is in London. I have met Col. H. C. Davis, of the N. Y. Electric Club, here several times, and though not actively engaged in electrical work, he still takes much interest in it.

At Venice there is to be erected a central station for 15,000 lamps, the Westinghouse system being employed.

CHARLES FFRENCH.

London, Dec. 10, 1889.

The Multiplex Telephone System.

TO THE EDITOR OF ELECTRICAL REVIEW:

As I do not remember seeing any account in the REVIEW of my multiplex telephone system, a short description will, perhaps, be found of interest. The object of the invention is to improve the working capacity of telephone trunk lines so that four persons may be able to use the same wires at the same time without interference. To accomplish this, two problems are required to be solved, namely, first how to render the central office receiver silent to the subscriber's transmitter, and second how to render the subscriber's receiver silent to the central office tranmitter. A metallic circuit trunk line is used and the subscribers may have either a single or a double wire service. In the former case his line is attached to the metallic circuit at the central office; in the latter case the metallic circuit is grounded at the subscriber's station. In case the subscriber is supplied with a single line, the ordinary transmitter and receiver are used in said single line, but when the subscriber is supplied with a double wire, special apparatus with double wound coils are necessary. In either case the trunk line transmitter and receiver are supplied with double coils, one coil being inserted in one branch and the other coil being inserted in the other branch of the metallic circuit. The trunk line transmitters are enabled, by means of these double coils, to charge each branch of the metallic circuit equally, simultaneously and in opposite directions. When the wires are so charged, the electrical currents move only in the metallic circuit and do not escape through the grounded branch lines and, hence, can not effect the receiver in the subscriber's line. In case the subscriber is provided with a metallic circuit, his transmitter and receiver are also double wound with a coil in each branch of the metallic circuit and on opposite sides of the grounded branch line. In order that the two systems shall be independent of each other, it is simply necessary to connect the coils of one system so that they shall oppose each other while the coils of the other system are arranged to reenforce each other. In the one case the electrical currents traverse the two wires of the metallic circuit in the same direction; in the other case these currents traverse the wires of the metallic circuit in opposite directions. In the first case the currents complete the circuit by means of the two ground wires; in the second case the currents move only in the metallic circuit. Hence by this arrangement of coils and circuits two persons at one end of a metallic circuit may cummunicate with two persons at the other end of said metallic circuit simultaneously, and without interference. Yours truly,

A. M. ROSEBRUGH.

PERSONAL.

Mr. Gilbert M. Smith, western manager of the Ansonia Brass & Copper Company, spent the holidays with friends in this city. Mr. Smith's energy and persuasiveness has built up a large business in the west for his company, and he abundantly deserves the success he has won.

Mr. F. W. Webster, purchasing agent of the Thomson-Houston Electric Company, Boston, paid New York a flying visit last week. Mr. Webster ably presides over one of the busiest departments of this great company, and his trips away from Boston are generally flying ones.

Mr. S. F. Austin, New York superintendent of the French Cable Company, found on his desk on Christmas Eve just before leaving his office a fine, massive, onyx parlor mantel clock, which his staff asked him to accept with cordial Christmas greetings, and as a slight mark of the esteem in which they held him.

Mr. Walter K. Freeman, electrician of the National Mfg. Co., Eau Claire, Wis., has been a visitor in New York for several days past. Mr. Freeman reports business very brisk with his company, which, although a new one, has now over 30,000 lights supplied by his system. The company has recently taken some large orders, over 4,000 lights being contracted for during the week preceding Christmas.

Mr. W. J. Hammer, who had entire charge of the very extensive and attractive Edison exhibit at the Paris Exposition, has returned to New York and is endeavoring to re-learn the language of the United States. Mr. Hammer is to be credited with presenting a very interesting and unique display of the many inventions of Mr. Edison, his idea of the phonograph pavilion, where all leading nationalities could speak into the phonograph in their own language under the direction of one of their countrymen, being especially novel and excellent.

Another good man who evidently prefers private wealth to official honor is Mr. Charles M. Catlin, the first assistant examiner in the electrical division of the Patent Office, who will shortly resign his position to connect himself with Dyer & Seely, at No. 40 Wall street, New York, who are the principal patent attorneys for the Edison and Sprague companies. Seven years faithful service in a responsible position requiring good executive ability and mature judgment; a knowledge of patent law and practice; familiarity with the state of telegraphic and telephonic art, always up to date; a salary of $150 per month and few chances of promotion—tax-payers have no cause of complaint on account of government extravagance in this direction.

To the Kansas City Convention.

The following preliminary railway schedule has been arranged for the meeting of the National Electric Light Association at Kansas City on February next. Should there be any change from this, the Committee on Transportation will announce it in good time:

Leave Jersey City	9.45 A. M., Sunday, Feb. 9th
Arrive Chicago	9.00 A. M., Monday, Feb. 10th
Leave Chicago	9.30 A. M., Monday, Feb. 10th
Arrive Kansas City	9.30 P. M., Monday, Feb. 10th

If the Committee can carry through the above schedule, it will be by far the quickest time ever made between New York and Kansas City.

An Electrical Soldering Rod.

A late invention of Charles E. Carpenter, a Minneapolis electrician, is an electric soldering rod, which he claims entirely does away with the many annoyances attending that tool at the present day. One advantage is that it can be made much shorter without the heat being felt by those who handle it. Another advantage is that it never cools off unless the connection is broken. It is intended for use in large tinsmith shops, where many are constantly employed.

Bill in equity was filed at Boston, Dec. 18th, in U. S. Circuit Court, by American Insulator Company for injunction to restrain the Electrical Glass Corporation from making double petticoat insulators, same being an infringement of patents held by the plaintiff.

Telephone News.

*** The Bell Telephone Company has declared a dividend of $3 a share, payable January 15th, to stockholders of record of December 31st.

*** The Providence Telephone Company is putting in a line of new poles between Providence and Woonsocket for the establishment of the metallic circuit.

*** A stock company has been organized at Cannon Falls, Minn., to build a telephone line to Randolph, where connections will be made with Northfield, St. Paul and Minneapolis.

*** The telephone exchange at Bangor, Me., is constantly adding new subscribers, and the telephone is gaining great popularity in that city for residence as well as business purposes.

*** The work of erecting telephone poles at Seattle, Wash., for the Inland Empire Telephone Company is rapidly progressing. The poles are 80 feet high and about 2½ feet through at the base.

*** The idea of a telephonic church is being carried out at Tunbridge, Wells, England, where the pulpit of a church is connected with 16 subscribers, including doctors, apothecaries, one clerk and invalids.

*** The instrument statement of the Bell Telephone Company for the month ended Dec. 20th, shows a gain in the net output of 1,085. For the instrument year the gross output has been 3,557 larger than for the previous year, and the net output 2,192 larger. Here is the comparative statement:

Month Dec. 20	1889.	1888.	Increase.
Gross output	5,010	3,949	1,061
Returned	2,140	2,163	*23
Net output	2,870	1,785	1,085
Fiscal year.	1888-9.	1887-8.	
Gross output	57,167	53,610	3,557
Returned	24,967	23,601	1,366
Net output	32,200	30,008	2,192

*Decrease.

The Autocrat of the Telephone.

Proprietor (at telephone)—Hello, central! What seems to be the matter? I have been trying for the last half hour to get you. Give me one-naught-five. [Waits ten minutes longer and no answer.] Dear, dear, this telephone puts me all out of patience. Here, Thomas, call up one-naught-five and wait till you get it.

Office Boy (giving handle a vigorous whirl)—Hullo—hullo! Say, central, w'at's achin' you! Why don't you git us one-ought-five, hay? Come, now, git on a rush there and shake 'em up or we'll drop onto you from de roof and paralyze you!

Central (obsequiously)—Yes, sir, I'll connect you right away; excuse delay, please.—*Time.*

Electrical Letter Stamp.

The Philadelphia post office has on trial a letter stamping machine run by electricity. It cancels about 25,000 letters an hour and registers each letter stamped.

A Good Chance.

The *Cosmopolitan* for January should wake up the other magazines and make them feel that they cannot rest on their oars. The illustrations are superb, the letter-press exquisite, and the reading is as bright and cheerful as a Yule-log in an open fire-place.—*N. Y. World.*

The ELECTRICAL REVIEW and the *Cosmopolitan* can be secured for $3.20 per annum, if subscription is sent in this month.

To Change the Patent Law.

Among a number of bills relating to patents, one proposes to change the lifetime of patents from 17 to 7 years, and another provides that any patent hereafter issued may be cancelled by special act and the payment to the inventor of not less than $50,000 nor more than $100,000, with authority to Congress to grant a further allowance to the inventor of the amount expended by him in perfecting his invention.

THE BROOKLYN SUBWAYS.

(*Continued from page 3.*)

every point but one, may, through contact at that one point, render a great length of ordinary wire fatal at *every* point to man or beast touching it. And this is exactly what happens in a large proportion of cases. A telegraph wire has fallen across an electric light wire, sawed through its insulation, and received its current; and some hapless victim touches, not the original conductor, but the naked secondary conductor, with terrible results.

To cure all the above evils at once the decree was made that all electrical conductors of every kind should be buried forth with underground. But it is certain that in the present state of electrical science, high and low tension currents should not be placed in close proximity, either under or above ground. Aside from the effects of induction (to be mentioned hereafter), it is not safe to carry through the same manholes the telephone wires connected with innumerable houses, and the cables conveying highly destructive currents. The board is quite aware of many apocryphal and a few authentic instances, in which this is said to have been done without difficulty or disaster. It is quite as possible, theoretically, by scientific devices, to secure safe insulation as to diminish to a minimum the disturbances of induction. So it is possible to enclose a keg of gunpowder beyond the danger of ignition, but that does not make it an advisable stand for a kerosene lamp. Or, a cannon may be so connected with clock work that it will not go off until noon; but nobody is therefore wise who sits down before it at half past eleven. In short, neither anything heretofore invented, nor anything likely to be invented hereafter, can render it advisable to collect unnecessarily the elements of danger, relying for immunity on the correct operation of scientific precautions, and the constant intelligence and vigilance of workmen. Consequently whether high and low tension conductors can or cannot be, they never ought to be buried in proximity.

It follows, then, that they should either be placed underground in entirely separate and suitably protected systems, or that one or the other, or neither, class should go underground at all. The last alternative may be rejected at once. Apart from all other reasons, the consideration of safety dictates as wide a separation of the two classes of conductors as possible. That they should be left to cross and tangle in growing multiplicity above ground is intolerable. Unless both can be practicably buried, then, which class shall we bury?

In answering this important question, the board contravenes high foreign authorities, who assert that the two classes cannot be operated underground, and that the true plan is to bury the high tension conductors, and have the telephone and telegraph wires in the air, free from perilous neighbors. With this conclusion the board does not agree, for the following reasons:

(*a*) It is not yet certain that electric light wires can be operated successfully through subways. The distinguished director of the Turin system in Italy, since he advocated to a member of this board the exclusive burying of high tension conductors, has seen his electric light cables fail, after less than three years' service. Until this practical question is settled, it would be unwise to risk all reform upon the most doubtful part of the problem.

(*b*) But whenever this question has been solved, as this board does not doubt it will be, then it is believed that the burying of both systems in separate subways will be practicable.

(*c*) Meanwhile, the telegraph and telephone wires can be so buried and separated, and their removal from poles and houses will remove the greater part not only of the nuisance, but also of the danger. For it is perfectly possible to make the high-tension currents, *if these numerous naked wires are out of the way*, as safe as they would be underground. But this cannot be perfectly done (though great improvement might be effected in the present state of affairs), so long as those wires remain.

If, then, it should prove impossible (which this board, however, does not believe) to devise any commercially practicable and safe method of operating underground conductors of high tension currents, the burying of telephone and telegraph wires, coupled with proper inspection and control of the dangerous aerial wires remaining, would be not intolerable as a substitute. And until that better result can be reached, this substitute should be adopted.

Hence, it was concluded, the feasible but partial scheme adopted by the board would not impede the further progress hoped for. While acting in this direction, however, the board has been constantly engaged in the study of further possibilities, watching all developments of practice elsewhere, corresponding with municipal and electrical authorities throughout the United States and in foreign countries, visiting in person or through its own experts the scenes of reported successes or failures, hearing inventors, consulting eminent practical authorities, and directing experiments. The general opinions to which it has been led are stated in the following pages of

THE PROBLEM OF ELECTRICAL DISTRIBUTION.

The public distribution of energy from central points of generation is one of the most important elements of modern civilization. Since light, heat, motive power, chemical energy, electricity, etc., are all forms of energy, convertible, the one into the other (though in the present stage of applied science with varying degrees of practical economy), it is evident that the vehicle of distribution which will safely, cheaply and conveniently deliver to the consumer all, or the greatest number, of the desired forms of energy, will ultimately find general adoption. This has been foreseen ever since "the correlation of forces" was established as a natural law, and the foresight has led to continual attempts to multiply the applications of existing modes of distribution. Thus, illuminating gas, originally giving light only, is now proposed for house-warming, cooking and (through gas-engines) motive power; and the motive power thus furnished is turned by a further transformation of energy into electric light, etc. Water under pressure of heat, steam and superheated water and compressed air are well-known conveyers of motive power. Into this field the electric current now enters as a carrier of energy, and although its mechanical apparatus is as yet far from perfect in economy, efficiency or safety, it has made, especially during the past five years, such wonderful advances, and it promises such advantages over other means, that it must be deemed a permanent improvement, certain to receive rapid extension; and provision must be made for it in municipal administration and engineering.

The telegraph and telephone do not employ large amounts of energy and cannot be used as vehicles of its distribution for other uses. Their currents are not dangerous,* although, as above explained, their conductors may become so.

The placing of such conductors under ground is not difficult. Whether it can be done in a given case without commercial ruin, depends upon the cost of the operation and the earning power of the conductor. Main lines of telegraph certainly can be fairly required to go underground in large cities. The earnings of the telegraph are proportioned to its business and limited only by the capacity of transmission. This capacity is somewhat reduced by placing the wires underground; but the loss is practically counterbalanced by reduced cost of maintenance.

Since a telephone wire usually earns only a rental, independent of its actual business, and the contract with each subscriber is terminable by him upon three or six months' notice, it is plain that unless a city be provided with subways reaching every house,† and permitting the introduction and removal of single wires without disturbance of pavements, neither the telephone company nor the city could endure the requirement that all the wires be put underground. The company could not spend hundreds or thousands of dollars to reach a subscriber who might cancel his contract after paying $25, and the city could not tolerate perpetual digging in its streets. Moreover, the only commercially practicable underground conductors of this class are cables, containing 50 or 100 wires each, and these wires must be separated and carried overhead to subscribers. It would be reasonable to require of telephone companies that their overhead conductors should be made of hard drawn copper instead of iron. They could then be made so small as to be scarcely visible at the height of an ordinary building, while they would also present less surface to collect ice or to be assailed by wind. The supports might consequently be further apart; and, whenever practicable, should be house top fixtures, or poles in retired alleys, courts or the interiors of blocks.

It is evident, therefore, that a part of a city telephone system will always be above ground—namely, the short terminal distribution to groups of subscribers, while another and constantly varying part will be temporarily above ground, namely, longer single wires, carried to subscribers so widely scattered that they cannot be grouped so as to be reached by short wires from the permanent terminals. This varying overhead portion should have the continual supervision of some authority, other than the telephone company itself, which can demand, at any time when the number of subscribers will justify it, that overhead lines previously permitted shall now be consolidated in a cable, and carried underground to a convenient terminal. This supervision, together with the work of improving from time to time the character and location of terminals, is a work of patient and constant study and of small details in administration. It should be in competent expert hands, and connected with a permanent department of the municipal government.

There are also in large cities the wires of the district telegraph companies, which earn little or nothing, wire and instrument being furnished to the subscriber at a nominal charge, or free, and the revenue of the companies consisting of the fees for messenger service, which are the same, whether the service be ordered by wire, mail, or personal application. These conductors go singly from the central station of each district on all directions and are practically terminal distributing wires from the start. They can rarely be combined in cables, so as to be put underground, even if the conduits were prepared for them. Such conductors should be subject to official inspection and control, confined to house-tops, and carefully so placed that they cannot by any ordinary accident come into contact with high tension conductors.

The conductors of electrical energy in large amounts, for transformation into light, heat and power, present a much more difficult problem, the pressing importance of which will be far greater in the future than it is to-day. The following outline, made as free from technical terms as possible, will perhaps enable the general reader to form a conception of its nature.

Electrical, like all other energy, involves two factors. As a certain amount of heat is contained in a given body at a given temperature, and an equal amount may be contained in another body, smaller or larger, but correspondingly hotter or cooler; or, again, as the energy of a rifle ball moving swiftly may be equal to that of a cannon ball moving slowly; or, as the energy of a slender stream of water falling from a great height may be the equivalent of that of a larger stream with small "head"; so a given amount of electrical energy may be expressed in a certain current with a certain "potential" or intensity, or in a smaller current with higher intensity.*

With a given expenditure of power, we can force through a long pipe either a small quantity of water at high pressure and speed, or a larger quantity at lower pressure and speed. But practically we must suit the size of the pipe to the purpose in view. The larger quantity requires a larger pipe; and if we go beyond a certain relation, the resistance of friction increases until it may finally stop our engine; or (if the engine has an automatic cut-off, and increases its effort to overcome the increased resistance, and is too powerful to be stopped) the water-pipe may burst. Finally, the amount of friction in the pipe depends also upon its material, shape and other conditions, apart from its size or the velocity of the current forced through it.

This familiar analogy presents condions roughly similar to those of an electrical conductor; but the strain thus produced is not ordinarily a bursting-strain, like that of water in too small a pipe. In the case of the incomparably intense and powerful current of lightning, rending effects are included; but the energy of artificial currents is transformed under such conditions into heat; and thus a conductor may be made white-hot by passing through it a current of relatively excessive quantity. This is the principle of the incandescent or "glow" lamps, in which a short conductor of small diameter and inferior conductivity is made to convey a current of relatively large quantity, and thus by its resistance becomes white-hot, although the same current in the larger copper wire on both sides of the lamp is carried without perceptible rise of temperature.

Just as a water-pipe, originally large enough, but becoming deformed or clogged by accident, may then behave like a pipe made too small, so the conductors of "quantity" currents of electricity may be accidentally affected so as to increase the friction of the current at certain points, and to become, at such points, heated even to whiteness. This is not the direct result of imperfect insulation. To recur to the analogy of water, a pipe that leaks is not more, but less, likely to burst, because the leak relieves the bursting-strain; and so a defective insulation, permitting the escape of a part of the electrical current prevents to that extent its transformation into heat. But indirectly, the defective installation of quantity-currents often leads, particularly in house interiors, to the danger-

* Except as any current which may under any circumstances give a spark, is dangerous in the presence of explosive gas—which the smallest spark may ignite.

† Objectionable on other grounds, as already explained.

* The analogy of hydraulics here employed may be open to objection, on the ground that the words "current" and "resistance" have a technical meaning among electricians, different from that which this analogy would suggest. The precise expression of the proposition above stated would be deduced from the well-known electrical formula: $W=EC$, in which W is the energy in watts, E the electro-motive force in volts, and C the current in amperes. It is evident that for the same value of W, the values of E and C may be varied indefinitely so long as their product is not changed.

For the purpose of this report, the analogy with the hydraulic formula is sufficiently accurate, although the further electrical equation

$$C=QT=\frac{E}{R}$$

in which Q is the quantity of electricity in coulombs, T the time in seconds, and R the resistance in ohms, indicates a distinction between "quantity" and "current."

ous heating of the wires. For instance, a building has been carelessly "wired" by the contractor, for incandescent lights. It is subsequently found that, by reason of the imperfect insulation, much of the current escapes into the walls, and the lights are dim. The easiest remedy is to put on more current, in order to give the lamps enough, notwithstanding the leakage, and in this way the parts of the circuit not relieved by leakage may become overheated. Several instances in which those or similar conditions have led to incipient conflagrations, are known to the board. The popular impression, therefore, that the low-tension, quantity-currents are perfectly safe is erroneous. Whether used for incandescent lighting or for the transmission of power, they carry the potential risk of fire. This can and should be adequately met by a rigorous inspection of the interior, as well as the street-installation of such systems. The underwriters' regulations have not been suitable. Some of their regulations have been unnecessary or absurd; others have been fatally deficient. The practice of the first-class electrical companies is usually good, but building-contractors are often engaged to "wire" new houses before any arrangements for the actual lighting have been made with this or that company, and their work, once hidden in the walls, is beyond inspection.

For convenience, the quantity-currents have been spoken of above as if they were always of low tension. This is not necessarily the case. High intensity and large quantity may be combined in the same current. Currents of sufficient intensity for many arc lights may be carried through incandescent lamps in the same circuit with the arc-lamps, and this is sometimes done, particularly in the illumination of industrial establishments, where both kinds of illumination are desired. (The method of reaching a similar result by the use of alternating currents will be described hereafter.) But practically the great incandescent systems (such as the Edison) employ low-tension currents. These can be easily operated underground.

Currents of high potential, whatever be their quantity, present dangers of a different kind.

In the first place, just as high pressure on a water-pipe tends to make it leak at all joints, though it may have seemed perfectly tight at lower pressures, so the "potential," "intensity" or pressure of an electrical current increases its tendency to leakage. This is counteracted by "insulation;" that is, by surrounding the conductor with a substance which is a so-called "non-conductor." All these non-conductors are really capable of conducting electricity; they simply do not conduct it freely, and since the electrical current chooses the easiest path, or rather divides itself, among all paths presented, in proportion to their relative ease (as water under pressure divides itself among different ways of escape, or air-currents employed in ventilating mines divide themselves among the different air-courses), it consequently does not in large proportion adopt a "non-conductor." That no such substance is a theoretically perfect protection, the following explanation will show:

The so-called "current" of electricity is the result of a disturbance of equilibrium between the two ends of its path. This disturbance of equilibrium is expressed by a difference in "potential," that is, of electrical pressure.

Water flows in the direction of the smaller pressure. If the pressure were equal on all sides, it would stand still. Under ordinary circumstances, the water in a main, pressed from behind by a pump, flows forward. It is true that there may be in the air or earth outside of the main, still less pressure than that which opposes the forward movement; but the water does not flow to that space, because the iron of the main and its tight joints are "bad conductors" for water. The pump-pressure may be increased, however, to such an extent that the water can force its way through the main with less effort than is required for it all to go forward. In that case, it will seek the space of lowest pressure surrounding the main. If that space were occupied with a pressure equal to that within the pipe, the water would not seek it at all. In other words, as everybody understands, the difference in pressure inside and outside of the pipe measures the strain to which the pipe is subjected. Its ability to resist that strain increases with the thickness of its material.

The case of electric currents is similar. The general "potential" of the earth is very low—so low as to practically be adopted as the zero of the scale; and hence we may conceive the electric current as striving to reach the earth with an effort proportional to its own intensity. It will take the longer road through its own conductor to an extent determined by the relative resistances of the various possible paths; and these resistances are dependent upon the nature of the substances to be traversed and the length of the path. A naked wire carried on poles is insulated by glass and wood at the points of support, and still more perfectly at all other points by air. If no accidental contact with other objects were possible, and if the air, glass and wood were always dry, naked wires thus strung would be sufficiently insulated; for dry air is one of the best non-conductors known, glass is another, and wood, though inferior to these, is still fairly good. Neither of them is perfect; their resistance is proportional to the length of the electric path through them; and lightning proves that there is a tension, beyond our present means of measurement, at which the electrical discharge may take place, through thousands of feet of "insulating" air, to the earth. But for the highest intensity that human machinery has generated a few feet of air give an ample insulation. Physicists have never been able to make the electric spark pass through more than a few inches of air. Perhaps even one inch of dry air would give more effective insulation than an equal thickness of any other practically available substance. Moisture impairs the insulating quality of air, and moisture collected upon solid non-conducting material may itself constitute a good conductor.

The safe insulation of high tension currents above ground, then, requires to the ordinary protection given by the glass, wood and air intervening between them and the earth there should be added protection against moisture and against accidental contact with other conductors, among which living bodies may, under certain circumstances, be unfortunately found. Such protection is not adequately given by the thin fibrous covering of the "underwriters'" wire, too often employed in street lighting. After a single season, this covering is affected by moisture, and becomes practically worthless. Moreover, every insulating material not absolutely solid and hard, or covered with some shield, may be sawed through by friction of crossed and tangled wires, and thus destroyed locally. Safe overhead installation, therefore, requires not only a thorough protective insulation, but also such choice of position for the wires that they shall not be liable to contact with others—particularly as the result of storms.

When high tension conductors are put underground, the difficulty of insulation is indefinitely increased, because the zero-potential of the earth is brought so much nearer to the high potential of the current; and the thickness of the protecting insulation, whatever it may be, is correspondingly diminished. The suspended portion of a naked wire between two poles, 20 feet above the earth, is probably 240 times as well insulated as a wire in a subway-duct two inches in diameter would be, though the whole duct were filled around the central wire with the best insulating material now known in commerce. For the earth (that is the wall of the duct which would be practically at the earth-zero of potential) would be, in the latter case, only an inch away; and the insulating material would not be superior to an equal thickness of dry air. It has been attempted, with some success, to surround underground conductors with air; and as an auxiliary insulation it is no doubt beneficial; but there is difficulty in keeping it dry and it cannot well be relied upon as the sole protection for naked wires. Nor does it prevent their accidental contact with one another. Finally, it may involve, for the accommodation of any considerable number of conductors, more space than could be conveniently given.

The principal evils resulting from the difficulty of insulating high tension underground conductors are two. First, they are liable to fail after brief use, by the sudden destruction of their insulation at single points. This may be the result of original defects in construction or in connections. It is at the joints that the failure most frequently occurs. And one of its most frequent forms is that of the so-called "disruptive discharge" of which more will be said presently. This is undoubtedly often produced by careless management of the dynamo, especially in starting or stopping, which may produce a violent electrical disturbance, analogous to the "water-hammer" occasioned in water-pipes by suddenly opening or closing valves, and thus greatly augmenting ordinary strains. Finally the failure of underground cables may be due to the accumulated effects of slow deterioration of the insulating material under the excessive strain to which it is subjected by the close proximity of the earth-zero of potential. Conclusive proof of this gradual process has not been obtained. It is difficult to obtain, because the usual daily electrical tests of operating companies are not delicate enough to detect it, and because failure, when it occurs, is local at some weakest or most severely strained point. But the general experience that underground high tension conductors fail within three years, points to such a constantly operating cause; and the fact that, under conditions otherwise alike, the strain upon insulation is much severer underground cannot be successfully denied.

All such failures require the renewal of the section of conductor in which they occur. They may be measurably prevented by care in construction and operation, and they may be retarded by improved quality and increased thickness of insulation. Considered as an element of expense and loss to the electrical companies, and thus indirectly, as enhancing the price and impairing the effectiveness of the service rendered, they constitute the first of the two evils referred to.

The second evil is that this escape of the intense current, being likely to occur at joints, and therefore in manholes, and being usually accompanied with a spark, may ignite explosive mixtures of gas. As already explained, the proper ventilation of the subway will reduce the danger from gas to a minimum. Nevertheless there is more or less risk in carrying currents which *may* thus be discharged with a spark through places where gas *may* have collected, notwithstanding all precautions. No absolute preventive of the disruptive discharge has yet been fully proven in practice, though some ingenious and promising devices have been proposed, to render it harmless in this respect. It can, undoubtedly, be so far avoided by careful installation and management as not to be more frequent underground than overhead; but there is this great difference, that overhead it usually does no more than spoil a piece of conductor, easily renewed, while underground, it may blow up a manhole besides. The board believes that (perhaps on the principle already suggested by one expert, of providing a path for the spark, which might effect the "sparking" outside of the conduit altogether) the dangerous possibilities of the discharge will ultimately be removed. In that event, it will remain merely a commercial injury, and high tension conductors in well ventilated conduits, not containing conductors of other classes, will be safe enough.

Meanwhile, the question is thus raised, whether *for such conductors*, it would not be better to use solid conduits, packing the insulated conductors in a mass of asphaltic concrete or other material, which would admit neither gas nor moisture. The board has examined several such systems, and has been favorably impressed with their apparent adaption, at least to special kinds of service. But it is compelled to admit that within the fateful three years (and usually in a much shorter period) they have failed for one reason or another. Certainly they do not permit with facility the making or changing of new connections. Any disturbance of them is likely to destroy the whole system. If a single conductor out of a number thus laid in one mass, should fail, it must simply be abandoned; the replacing of it with another would be impracticable. Finally, all these solid conduits of various concretes are liable to crack somewhere, sooner or later; cracks admit moisture and moisture is rapidly fatal to the insulation.

Open conduits have been successfully operated in cities like Washington, where the wide streets, or some other circumstance, make the danger from gas inconsiderable. In such cases the above considerations may be neglected.

Besides the results of imperfect insulation above discussed, the disturbing effects of induction upon telegraph and telephone wires must be considered. An induced current is set up in any insulated conductor by every change of electrical condition in a neighboring conductor. The induced current is strongest when the two conductors are parallel, and least (practically nullified) when they are at right angles. This is due to the fact that the induced current is in the opposite direction from the inducing current. If two conductors cross at right angles, the two halves of each tend to produce in the other, currents in opposite directions which destroy each other. Similarly, if the outgoing and incoming wires of an electrical circuit be laid closely parallel or twisted together, they will tend to produce in a parallel conductor, presumably equi-distant from both of them, two contrary currents, thus measurably neutralizing the inductive effect.* Induction shields, to receive the inductive effect, and, partially at least, convey it to the earth, have been proposed. Iron pipe or the lead covering of the underground conductors may serve such a purpose. It is quite practicable in such ways to reduce the effects of induction to a tolerable minimum; and it is probable that overhead installations, where the natural insulation is superior, are more troublesome in this respect than underground ones. But the general practice of electric arc lighting companies, of carrying their wires on extended circuits, so that every conductor exposed to their inductive influence receives the effect of one wire alone, without the counteracting effect of its fellow, will probably have to be stopped. And this is one of the features of installation which should be under public control. For the same reason, grounded circuits will probably have to be abandoned for all kinds of electrical service in cities, except, possibly, the telegraph; and complete metallic circuits will have to be substituted—a change which may be made progressively, and under proper expert authority.

The distance at which induction, if not remedied in some way, may cause a perceptible disturbance, is not well settled; but there is no doubt that it is greater than the average width of a street. The Edison system of telegraphing to and from moving trains, reported to be now in use on the Lehigh Valley Railroad, is an instance. A message sent along the telegraph wires by the side of the railroad, by means of the Morse signals, produced by "making and breaking" the current (that is, by rapid changes of electrical condition) repeats itself by a repetition of such changes upon a closed circuit contained within a car of the moving train, and wholly disconnected from the telegraph line. This smaller circuit of wire includes a telegraph instrument, by means of which the changes of condition are made audible in the usual way, and the message is read. Induction, however, is weakened as the square of the distance increases.

It is not, therefore, the intensity of the inducing current, but its irregularity, which causes induction. And hence the so-called alternating currents, which are reversed with great rapidity many times per second, are the most powerful disturbers of neighboring wires. The inductive effects of telegraph and telephone wires are lively but weak, and are perceptible on telephones lines only, in the form of cross-talk, or the racket of Morse instruments interfering with the hearing of messengers. Even the induction from alternating currents can be rendered comparatively tolerable by the adoption of the remedies above described.

It is to this phenomon of induction, presented in a maximum degree by the alternating current, that one of the greatest modern advances in the application of electricity is due; and since the "alternating system" is destined to receive a very wide extension, and to affect in important particulars the municipal problem under discussion, a simple statement of its peculiarities, in popular language, will here be given.

As has been remarked, a given amount of electrical energy may be conveyed by a current, either of small amount and high potential, or of larger amount and lower potential. Now (to confine ourselves for the moment to electric lighting as the use of the energy), it has been shown that the Edison system, for instance, with its low tension current and incandescent lamps, is (when properly installed so as not to be liable to set fire to house interiors) not dangerous to human life. Moreover, it is successfully operated underground, on a system admirably perfect in ingenious device and mechanical execution. The incandescent light is the best indoors; and for ordinary street lighting, it is really the best out-doors. The substitution for the old gas lamps, of incandescent lamps of equal number and say 25 or 30 candle-power, would give a diffused street illumination, free from the black shadows and irritating fluctuations of the arc lights, and certain to be more satisfactory to citizens.

Why, then, should not this system be adopted, and high tension currents excluded altogether? This interesting question involves important commercial interests, but will be frankly and impartially discussed. So far as the public action of the board is concerned, it has been consistently in favor of the Edison system. As compared with any other system now operated in Brooklyn, whether for street lighting or domestic purposes, it is undoubtedly superior; its introduction into the city after a prolonged struggle with adverse interests was a public benefit; and its use in our streets would be another. Nevertheless, the system labors under commercial disadvantages, which make it almost impracticable for the wide distribution of light, and will probably prevent it from becoming the "system of the future," although the incandescent lamp will very likely be the lamp of the future.

The principal disadvantage lies in the fact that the low tension current requires large conductors and expensive machinery, and cannot be operated for more than a mile, at most, from the central station, without such cost in copper, etc., as prohibits its commercial use; whereas high tension currents carrying an equal amount of energy can be generated with cheaper plant, and conveyed by smaller conductors for many miles. Electric arc lights are operated in Brooklyn as much as eight miles from the dynamo.

But some high tension currents can be transformed at any desired point into electrical energy of larger quantity and lower potential, and utilized in that form for incandescent lighting. In other words, the energy packed for cheap transportation in small quantity can be unpacked and expanded, as it were, in order to utilize it in quantity. This is possible with the so-called "alternating" currents, from which, by means of so-called transformers or converters, induced currents may be obtained, representing portions of the total energy of the original current, but in different proportions of the two factors, quantity and intensity. The alternation—*i. e.*, the swift successive reversals—of this current, giving the maxi-

* Measurably, perhaps not entirely, since the currents in the contiguous outgoing and incoming wires may not be of equal intensity and quantity, and the strong outgoing current may exercise more inductive influence than the weaker return current can counteract.

mum inductive effect, is what permits "conversion" in this way. A "direct" continuous current produces induction by its fluctuations only, after it has once started; and such fluctuations, kept as small as possible in order to secure uniform work, are too insignificant to be utilized by conversion.

Without describing the details of the converters of the alternating systems, it is sufficient to say here that the main wire, carrying the high-tension alternating current, is not tapped by any metallic connection. The coil which receives the less intense current is simply brought near to the main current, and thorough insulation separates the two. No instance has ever come to the knowledge of this board in which the intense current has escaped to the conductor thus brought near to it. Such proximity in a carefully constructed, locked apparatus, accessible to trained experts only, is a very different thing from proximity in the air or in manholes frequented by more or less unskilled workmen.

The cheapness of high-tension currents, and the fact that with given conductors already laid, and burdened up to the safe limit of quantity, the only way to increase the delivery of energy is to raise the potential, has led to a constant quiet advance on the part of the electrical arc light companies. Almost without exception they use more intense currents than they profess to use, or formerly did use. An arc light company having a certain number of lamps "in series" (that is, strung together so that the current passes successively through all, losing a certain number of "volts" of its intensity at each) can only extend that series by increasing the intensity so as to supply additional lamps; and since this requires no additional station-plant, the temptation to do it is strong. Increased intensity may also be resorted to for increasing the amount of light at each arc. Consequently, companies which began with 1,500 volts, not infrequently employ 2,000, 2,500 and 3,000.

The "quantity" currents cannot be thus increased in quantity, upon the same conductors. Since the incandescent lamps consume principally quantity of current, they are usually set (in the Edison system) "in multiple arc;" that is to say, a certain portion of the current is switched off at intervals to pass through a group of incandescent lights, after which, in diminished quantity, it joins the main return current. Hence the conductors are made largest nearest the station, and are diminished gradually, for economy, as the current is diminished by the serving of successive groups of lamps. It is not practicable beyond narrow limits to extend the system once planned for a certain area.

The alternating currents, consisting as they do of rapid reversals of current, each of which constitues a separate shock, are, *at the same potential*, more destructive to life than the direct continuous currents. But the difference is not of much practical importance at a tension of 2,000 or 3,000 volts. Either current under such circumstances is sufficiently fatal. And since the irresistible commercial tendency is towards higher potentials, it will probably be found safer in the end to adopt very high tension, and to use the alternating currents.

For the currents are dangerous either through direct contact with man or beast, or through contact with other conductors which may indirectly lead to the same result. Now the alternating current may be put underground beyond any risk of the first danger; and the second danger may be entirely confined to the transforming apparatus, accessible to experts only. It is perfectly feasible to distribute electricity in this way, from a current of 10,000 volts intensity, carried underground, so that the working currents everywhere used, and the only ones exposed to any chance of accidental contact, shall be no more intense than 500 or 100 or 50 volts, according to the work required of them. A main alternating current of 10,000 volts is now carried in this way into London, and reduced to much lower potential (though not so low as the above) for arc lighting.

The economical details of such a scheme have never been perfected. They would be affected by many conditions—among others, the great question, not yet satisfactorily solved, of the duration of underground conductors under high tension. But this much is certain: the earning power of a conductor conveying a very large amount of energy is so much larger, that its owners can afford to spend much more to make it perfect and keep it so. Moreover, such a conductor would be buried in a conduit without manholes—or at least without such manholes as are required for connections and joints and the perpetual change of cables, and are therefore frequently opened and entered by common laborers. All the conditions of safety and permanence once found advisable could be vigorously maintained.

There is one drawback to such a scheme. The alternating currents when "transformed" produce alternating currents only; and these, though they will support both arc and incandescent lights, will not furnish motive power. Attemps to get a direct current out of an alternating one for this purpose, have not yet, so far as known to the board, proved entirely successful—although this statement is made with some hesitation, in view of the rapid progress of practical electricians and inventors. But if this has not yet been done, it is almost certain that it will be done. That there is nothing impossible about it is proved by the fact that the dynamo itself generates alternate currents, which are combined into the ordinary direct current by the "commutator." When this transformation shall have been achieved with the induced alternating current, so that from high tension canductors of that class continuous quantity currents of lower tension can be derived for motive power, the advantages of this system will be complete.

The progress of such electrical improvements is both helped and hindered by the competition of patented systems. Discussion of them in the newspapers is usually colored by commercial interest—each party disparaging the system which it does not own and is not permitted to use. Absolutely fair and thorough competitive tests in practice, and the final combination of the best features of all systems into one best system for each set of conditions will take place only when by commercial consolidations the ownership of essential patents is centralized, or by lapse of time they have become public property. Evidences of the former process are not lacking, and it may at any moment produce important alliances, greatly widening the field of choice as to the details of electrical installations.

Such being the actual present and probable future of this problem, the following suggestions are offered as to the legislation best adopted to meet it, especially in this city:

1. Since the space under the streets is limited, the city ought not to surrender it, beyond recovery on reasonable terms, to any private company. For if at last the perfect comprehensive system should be reached (in the direction above indicated or in any other), the city would be most unfortunate if by grants already made its free action in the matter were prevented.

2. The placing of telegraph and telephone wires underground may be continued without fear of interfering with the future comprehensive system; for these wires will never be advantageously included in the same conduit with the other classes, and, since they constitute by far the larger present nuisance (and, in the neighborhood of high-tension currents, indirectly the larger danger also), they ought to be buried as fast as possible.

But this should be done under official control, not limited by law to single, rigid functions, but clothed with full power for the regulation of all overhead as well as underground systems.

3. It is of the highest importance that the city itself should take the lead in this matter, by putting its police and fire telegraph lines underground. In those cities, outside of Brooklyn, where the largest amount of underground electrical service has been provided, the city has thus set the example. In Brooklyn it has lagged in the rear, and hundreds of poles from which the private wires had been removed, have remained in our streets, as plain a nuisance as before.

4. Either the executive authority, controlling the electrical conductors, should also make contracts for street-lighting, or the department making such contracts should act in harmony with it and according to its advice. The plan of contracting for the whole city, or for very large portions of it, with a single company and for a single year, though it may secure a low price, does not promote the progress of imprevement and the ultimate selection of the best system. The short contract encourages neither permanent installations nor experiments for better service. The cheapest plant is the best—for one year, and the construction of subways for so short a certainty of use is out of the question.

Probably equally cheap service, with far greater perfection, could be secured by a system of district contracts, under which rival underground systems might compete side by side, in adjoining districts—all being under continuous and rigid inspection and held to careful specifications as to quality, uniformity and safety of service. Such contracts, in order to secure a low price to the city, would have to be for a longer period than one year—say five years at least; and probably special privileges as to the supplying of private customers through street conduits would have to be added as a final inducement, being carefully guarded. (For the next five years, there is little danger of extortionate charges for domestic lights. The electrical companies are competing with gas, and can only get that business by bidding as low as possible.) At the end of the period of contract, the city should be free to act as might seem wise—either abolishing, modifying or continuing the district system, and selecting for further service those methods which had proved best in practice. The control of the street space and the ownership of the conduits should revert to the city, on equitable terms stated in the contracts.

A plan of this general nature would involve a monopoly, it is true; but it would be limited in area and time, and under close supervision. On the other hand, such a plan would put rival systems into intense competition as to excellence of service, and would constitute a conclusive test, in which every citizen would take part. Moreover, it would hasten the solution of the remaining difficulties of the subject by the most capable—almost the *only* capable—persons. For the best practical electricians are unquestionably in the service of the electrical companies. If it can be made the interest of these companies, not by unreasonable threats, but by fair business inducements, to operate underground, they will find ways and means of doing so, sooner than any one else.

5. Whether any such plan be followed or not, the details of electric light installation should be subject to inspection and summary control by some authority outside of the companies themselves. The inspection exercised by the underwriters furnishes a simple model. No arbitrary order could command more prompt obedience than does the simple notification of an insurance inspector that unless a certain danger be removed, insurance will be voided; and a provision of law, subjecting electrical companies to exemplary damages in every case where notice of a dangerous defect, given by the electrical inspector, had been disregarded, would probably be effective. But the proper authority should also have power of summary action, in case of such disregard.

By order of the Board.

(Signed) G. W. PLYMPTON, *Prest.*

APPENDIX.

In addition to the above report of the board there are several additional reports from the officers of the companies operating electric lines in Brooklyn. The report of the superintendent of the Western Union Telegraph Company states that his company operates lines distributed as follows:

	FEET.	CONDR.	MILES CONDRS.
On Elevator Railroad	3,700	19	13.31
On Poles	52	29	.30
"	30,340	12	46.33
In N. Y. & N. J. Telephone Subways	5,810	19	20.72
" " " "	2,293	10	4.34
" " " "	3,933	37	27.56
Total	36,128		112.58

The report of General Manager Sargent, of the N. Y. & N. J. Telephone Company, shows the condition of line work in his company to November 1, 1889, in the following table:

	MILES.	MILES.
Length of conduit November 1, 1889		16.722
Length of duct November 1, 1889		106.149
Length of cable underground November 1, 1889	24.976	
Length of cable elevated R. R November 1, 1889	14.760	39.736
Length of conductors underground November 1, 1889	2954.875	
Length of conductors elevated R. R. November 1, 1889	1399.482	4354.357
Number of subscribers working through underground and elevated R. R. cable		2,718
Aerial wires removed December 1, 1888, to Nov. 1, 1889		411
Poles removed December 1, 1888, to November 1, 1889		71 poles.
Poles from which telephone wires have been removed but which remain for city use		271 poles

General Superintendent Reilly of the same company also submits a report to the board in which he says:

"Terminating either an underground cable, or a cable placed upon the elevated railway structure itself at some convenient point on the road, we run rubber covered wires from that point in a distributing box, six inches square, which is placed along the footway between the tracks, to the points opposite where it is desired to branch them off. The wires are then dropped through holes in the bottom of the box, run along the cross-girder of the road to the curb line and jumped directly into the subscribers offices or to a branch pole line or house top fixture. Where there is a group of subscribers in a block it is the practice to branch a cable containing 10 to 25 conductors from the main cable on the road to a convenient point in the block and distribute over housetops from there.

"We had decided to place some 30 miles of conference standard cable in our underground conduits and upon the elevated railroad structures during the year, but we were fortunate in perfecting and applying a very simple and effective method of transpositions, which enabled us to reduce our cable purchases one-half. * * * *

"Close observation of the creosoted conduit and the lead-covered cables laid at various times since 1884, seems to prove that the destructive agent usually present in freshly-creosoted wood disappears almost entirely after a few years.

"A Western Electric cable purchased in 1886 and placed in the 1884 conduit during 1887, over two years ago, shows but very slight trace of action on its surface at this date, while part of the same cable laid in the 1888 conduit shows quite a scale of carbonate of lead after one year's exposure. Parts of the same cable placed in other conduits about a year after their construction show but little damage on the surface.

"A Western Electric cable placed by the Metropolitan Company late in 1885 in a creosoted conduit between the Brooklyn central office and the Brooklyn bridge, when examined a few days since, after three and a half years' exposure, shows a slight crust of carbonate, principally on the upper part. A N. Y. & N. J. cable laid in the same conduit in 1886 is in the same condition. We do not anticipate the loss of either of these cables from the action of gases. To further test the effect of time and ventilation on creosoted wood, we placed samples of the Western Electric and N. Y. & N. J. cables covered with the alloy of tin and lead in a box made of creosoted wood, which had been on hand in the yard for two years or more, and samples of the same cables in a box made of creosoted wood which had been on hand about eight months.

"After being sealed up for three months the boxes were opened, and the samples in the old wood box were found to have but infrequent patches of what is known chemically as phenolate, while the samples in the box made of the later lot of wood were thickly covered on the sides and top by phenolate. Either phenol, a volatile gas, or acetic acid in combination with carbonic acid gas will reduce lead to carbonate of lead. There being no acetic acid in the wood properly treated with dead oil of coal tar, and the phenol escaping by evaporation and ventilation, the carbonic acid gas present will in all probability have no more effect on the lead covering than if the cables placed were in ducts of iron or other material. It would seem desirable, therefore, before placing creosoted conduits underground, to expose them to the air or to artificial means for evaporating the phenol from the creosote, if the latter cannot be obtained free from it. There seems to be no doubt as to the durability of creosoted wood. Frequent examinations during the past five years show there is no decay of the wood or change of any kind to cause injury in placing or removing cables. Its economy, flexibility and safety strongly recommend its use for conduits.

"Our examination of the cables in use seems to show that there is a difference in the alloy covering. The Western Electric cable, covered with the alloy of lead and tin, placed January, 1885, in a conduit completed the previous month, is to all appearances, in as good a condition as when first laid nearly five years ago. It will be remembered, the cables covered with pure lead were destroyed and removed from this conduit.

"A Western Electric cable, supposed to be covered with this alloy, purchased in 1886, and placed in the conduit in 1887 with cable referred to above, shows a slight trace of carbonate, while part of the same cable, placed in a newly laid conduit, is severely attacked, as stated in remarks on conduits. The cable first referred to above, is in fact the only one we have which can be said to show no action on its surface. We are now having chemical tests made on specimens of several cables, to determine, if possible, the difference in their composition.

"The practice of ventilating the conduits and manholes, as they are constructed, by lateral branches to poles and housetops, and to which we ascribe our freedom from explosions, have been extended considerably during the past year by placing three-inch iron pipes from manholes to the columns of the elevated railroad, which serve the double purpose of ducts and ventilators. The quantity of gas in conduits and manholes has been sensibly reduced, and in two instances where conduits entered central office basement, the odor of gas which it seemed impossible to entirely exclude, disappeared entirely after the manholes were connected to the elevated railroad structure by a number of three-inch pipes. A large tube leading to a dead chimney at this office, in connection with pipes to elevated railroads near by, usually keeps the large tunnel through which the conduits enter the building pretty free from gas.

"We believe ventilation of this kind is the easiest and best method of preventing the explosions in manholes occasionally reported from other cities.

"Experience confirms our belief that manholes should be made large and roomy, with hooks or guides on the sides where cables and junction boxes may be arranged out of the way of workmen engaged in drawing cables in and out.

"Except the cables removed on account of destruction of the lead covering, we have had no special trouble with either cables or terminals, and the electrical condition of our cables remains practically as reported last year. All cables connected during this year give satisfactory results in insulation and capacity."

THE OPINION OF THE ATTORNEY OF THE BOARD.

Mr. James McKeen, the counsel of the

Subway Board, in an interesting opinion of the present situation, says:

"Section 6 of the law of 1885 provided that the term of office of the commissioners should expire on the first day of November, 1887, or sooner upon the performance of their functions. By an amendment to the act, passed in 1887, it was provided that the terms of office of the Brooklyn Commissioners should extend until November 1, 1889, unless their functions should have been performed sooner. Although the act as amended did not in terms fix the limit of the duration of the board itself, and although the provisions of section 6 of the act suggest its continuance by providing that the Governor should have power to appoint successors, there is no room whatever for doubt, taking the whole act together, particularly the provisions of section 9, that the life of the board as such becomes extinct with the expiration of your present terms of office. * * *

"The condition which will result from the expiration of your term of office is one full of perplexity. As you are aware, in accordance with your instructions, I called the attention of the city authorities early last winter to the importance of such legislation as would enable the work to be continued. It was suggested by me that the duties of the commissioners under the subway acts might be devolved upon some branch of the city government. It was, however, thought by the Mayor wiser that the life of the board itself be continued, and a bill was introduced at the request of the Corporation Counsel, extending the life of the board and giving the Mayor power to appoint successors. This bill failed on its final passage through the Senate, chiefly owing to the opposition of Mr. Senator Worth. It was then too late to pass any alternative measure. The existing situation will no doubt compel further legislation at an early day. My own judgment is that a separate department or bureau should be created in the city government, looking to a permanent control of electrical conductors in the city.

"The Act of 1884 imperatively requires that all electrical conductors shall be placed under the surface, and that act required the local government of the city to remove after November 1st, 1885, all telegraph and electric light cables and poles wherever found above ground within the corporate limits. This act remains unrepealed, except so far as it is inconsistent with the provisions of the Act of 1885. The main purpose of the Act of 1885 was to create a commission who should solve the scientific difficulties supposed to exist, should devise under certain limitations a general plan and system of underground subways and compel the electrical corporations to use them, the commissioners having power to grant deviations from underground systems and allow aerial wires to be used in certain cases and contingencies. It is very obvious that the Legislature in 1885 had no conception of the extent of the work which would be required fully to carry out an underground system. As has already been shown in your own very full reports, it has been impossible under the limitations of your powers in the act, to devise and successfully put in operation a plan which could include the high tension and alternating currents in the subways adapted to ordinary telegraph and telephone wires. The Legislature in 1885, perhaps, had no reason to anticipate the enormous extent of the business involving the use of electrical conductors in cities. Moreover, companies operating the telegraph have certain rights to the use of streets by virtue of the general act under which they are incorporated. They are general servants of the public *as carriers of messages.*

"The various companies distributing electricity for purpose of light and power are in a different category. They have no rights, by virtue of their corporation, to the use of the public streets for their conductors, either above ground or under ground. They have had recourse to the city government to obtain franchises for their businesses, but after obtaining such franchises they continue to be subject to the provisions of the subway acts to the same extent as telegraph companies.

"At an early stage in the life of your board the question arose as to the continuance above ground of the wires used for arc lighting. The question was at that time referred to the learned corporation counsel, whose opinion was that until a subway should have been devised and prepared, in which these wires could be operated, they should be permitted to continue. I have had no occasion to dissent from the opinion in the matter of the corporation counsel, but I have not construed it as a warrant for the indefinite extension and continuance of the overhead electrical conductors. The city officials, however, have, I believe, allowed these to be extended, without any permits from your commission, construing such extensions to be within the terms of the various franchises conferred by the Common Council upon these companies. In view of the expiration of the commission there would seem to be, after November 1st, no board or department of the city government having power to permit aerial wires. I am unable to discover how they can be lawfully extended or maintained except in accordance with such permits for deviations from underground systems as may have been granted by you. It would seem that the duty becomes again affirmatively devolved upon the local government of the city to remove them, wherever found above ground within the corporate limits. In short, it seems to me that the object of the creation of the commission by the Act of 1885 was to enable all companies authorized to use electrical conductors in the city to get their conductors underground with the aid and approval of the board, they having the right, in certain specified cases, to deviate from an underground system where that was discovered by the board to be impracticable. If companies themselves have been unable to devise and get in operation a successful underground system, and have failed to procure from the board the requisite permission to deviate from such a system, it would appear to be their misfortune."

The concluding report is from the inspector of the board, who describes the routes and wiring of the Municipal Electric Light Company of Brooklyn, and of the Citizens' Electric Illuminating Company of the same city.

Another State Organizes.

The Connecticut Electric Lighting Association was formed on Monday of last week at New Haven, Conn., the meeting being held in the pleasant offices of the New Haven Electric Light Company. The meeting was well attended, and the value of such an organization generally discussed.

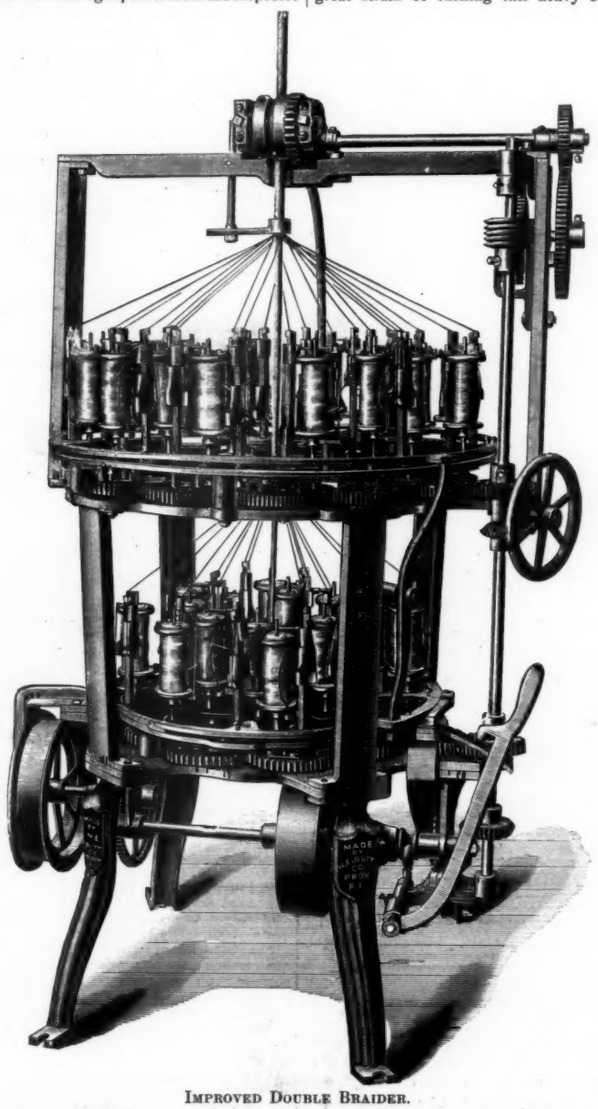
Officers were elected as follows: President, James English; 1st vice-president, J. A. Hadley; 2d vice-president, J. P. Stow; treasurer, John C. English; secretary, A. M. Young. The executive committee is composed of the officers *ex-officio*, and Messrs. L. S. Beardsley and F. F. Fusenich.

This is the third State organization of electric lighting interests, the other two being Massachusetts and Maryland, the latter including the District of Columbia.

New Heavy Double Braiding Machine for Covering Cables and the Larger Sizes of Wires.

The greater power and covering capacity demanded by the increased size of wires and cables has compelled the construction of more powerful and stronger machinery for the purpose. We illustrate this week the new double 16x24 braiding machine, just brought out by the New England Butt Co., of Providence, R. I., for this purpose, a machine that meets the requirements perfectly. It carries the large bobbin, 4½-inch traverse, 3-inch head, with weights varying from three to 20 ounces, thus allowing the use of a coarse covering material.

A new principle of driving the take off reel is adopted in this machine, power being taken direct from the driving shaft, thus relieving the feeding mechanism from the great strain of turning this heavy coil of wire or cable. All the parts are built strong and substantial, with a view to meet the requirements of this class of work. The work of this company is uniformly successful, and in addition to manufacturing braiding machinery, a great deal of casting is done for electric manufacturing companies.



IMPROVED DOUBLE BRAIDER.

Who Will Answer This?

TO THE EDITOR OF ELECTRICAL REVIEW:

Will you please advise me by whom and where the first electric light plant was installed in this country? R. G. POST.

Oswego, N. Y., Dec. 24th.

—— The Thomson-Houston plant at Joliet, Ill., is in readiness for operation. The machinery is all in position and all connections made. The company announce that they will begin to light the city on Monday night next.

ELECTRIC LIGHT NEWS

—— The City of Columbiana, Ohio, is to be lighted by incandescent electric light for five years at $1,250 per year.

—— The Thomson-Houston Electric Company is adding to its factory apparatus at Lynn. In its blacksmith shops four new fires will be started soon.

—— There seems to exist at Lynn, Mass., a growing fear among the residents of that city of being crowded out by the constant extension of the Thomson-Houston works.

—— The Electric Light Company, of Albion, N. Y., is pushing its plant rapidly toward completion. The engines are being set and the poles are nearly all in position.

—— Belvidere, Ill., is about to establish an electric light plant within its precincts. The central station will be equipped with Westinghouse alternating current apparatus for a capacity of 750 lights.

—— The Westinghouse Electric Company will ship a 750 light apparatus, alternating current, to Lynchburg, Va., in a few days. A local company has just been organized in that place with indications of a very successful business.

—— Mayor Hart, just returned from the great city where the mayor has been cutting down the electric light poles and leaving the streets in darkness, declares that the electric lighting system has come to stay, and that it is the business of city officials to render it safe, not to abolish it.—*Boston Transcript.*

—— At the annual meeting of the stockholders of Winchenden Electric Light and Power Company, held at Gardner, Mass., last week, the old board of directors were elected with the exception of two new members who take the place of those who had been previously elected and declined.

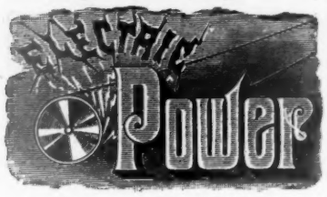
—— The London, Ohio, council has passed another electric light ordinance, repealing the one granting John C. Winchester the right of putting in a plant of 65 lights at $53 per lamp per year, and contracting with Mr. Winchester to put in 40 arc lights and maintain the same for ten years at $80 per lamp per year.

—— Mr. Barnes, New England agent for the Westinghouse Electric Company, closed a contract very recently with the Greenfield Electric Light and Power Company, Greenfield, Mass., for a 740 light alternating dynamo. A contract was also closed with L. B. Clark & Company, Kingman, Me., for a 75 light isolated plant.

—— Andrew Kirkpatrick, counsel for the Newark (N. J.) Electric Light and Power Company, has filed a mortgage for $250,000 given by that company to the Fidelity Guarantee and Trust Company, as trustees. The Fidelity Company will at once issue electric company bonds to the amount named, the bonds being secured by the mortgage.

—— The Searle estate of Great Barrington, Mass., generally known as the Kellogg Terrace, is being wired for an electrical installation of which the designs are all special. The electric lighting, electric bell and electric gas lighting work is all done with special wire, and in the former two cases heavily insulated wires run through conduit tubing which is all concealed in the moulding. Very few electroliers are used throughout the house, the incandescents being so placed as to light the room by reflected lights.

—— The new power house of the American Electric Light Company, at Carthage, N. Y., was completed a few days ago. The company's plant was moved into the new quarters on the 22d inst. The building is three stories high with dimensions 30x50 feet. The roof and sides are covered with sheet iron, which makes it absolutely fireproof from the exterior. Under a 10 foot head are two Turbine water-wheels of 175 horse-power. The dynamo room is 20x25 feet, and the dynamos will stand on a solid bed of masonry laid up 10 feet from the rock foundation. There is built 60 feet of flume and bulkhead and 200 feet of dam.



* * The Springfield, Mass., aldermen have given unanimously the right to use the single trolley system on the Springfield street car line.

* * The Fort Defiance electric road is being constructed at Tacoma, Washington. The road will be six miles in length and must be completed in 60 days. The storage system will be used.

* * An ordinance has been passed at Burlington, Iowa, granting a local company the right to construct 10 miles of street railway upon such streets as they may select. Work is ordered to be begun by May 1, 1890.

* * The Thomson European electric welding patents are said to have been sold to the City of London Contract Corporation. The same company has made other large purchases in this country, including the St. Louis breweries.

* * The work of preparing the entire system of horse railway, at Atchison, Kas., for electric motor power will be commenced at once. For this purpose $100,000 will be expended. It is expected to do away with horse power entirely by April 1, 1890.

* * A stock company will be formed at Greenville, S. C., with a capital stock of $30,000. The company which is to be made up of Greenville's most prominent citizens will build an electric railway from that city to the Paris Mountain Hotel, on top of Paris Mountain.

* * The proposed electric railway through Weymouth and Hingham, Mass., will have a capital of $100,000 and 17 miles of roadbed will be built. The temporary directors are Peter W. French, John A. Fogg, John W. Hart, John Carroll and Frank H. Torrey of Weymouth, Joseph Burdett, George Cushing and C. Sumner Cushing of Hingham, and W. A. Stiles of Newburyport.

* * A very large electric motor plant is located at Valparaiso, Chili. The plant will be centrally located to supply the manufacturers of the city. The plant cost $125,000 and has a total capacity of 500 horse-power. Huyler, the famous confectioner of New York, has installed a 60 horse-power generator and a 50 horse-power electric motor for running the machinery throughout the factory.

* * A meeting of the Beverly and Danvers Electric Railroad Company, held at Beverly, Mass., on the 23d inst., resulted in a vote to lease the road to the Union Electric Car Company, of Beverly, Mass., who are at present operating the road with their storage battery system. The Union Company will guarantee a certain per cent. for dividends, and will extend the tracks in Beverly and Danvers.

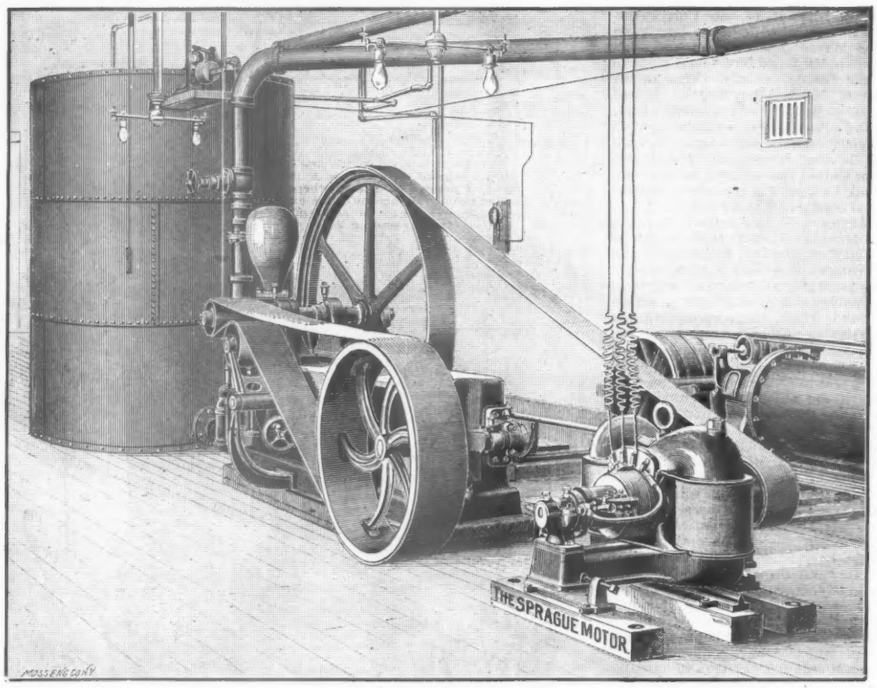
* * The Electric Car Company, of America, recently gave an exhibition at Philadelphia, Pa., of its storage battery cars, at which time the round trip of six miles was made over the tracks of the Lehigh Avenue Passenger Railway. The car used was 30 feet long over all and was carried on two trucks. The motor is said to differ from any so far brought out. The power reaches the axles through worm gearing which runs in oil in a suitable casing, and is noiseless and very durable.

* * A meeting of the corporators of the Essex Electric Railroad Company was held in Salem, Mass., recently, and the stock book was opened. Each signer is entitled to 20 shares, the par value of which is $100. There are 25 signers and the capital stock is expected to be $50,000. There is a good demand for the stock and it will probably be taken up at once. The local people will hold enough of the stock to assure a controlling interest, and the terms of sale will be ten per cent. cash, 40 per cent. within three months, and the balance on demand thereafter. Work will be begun on the road early in the spring.

* * The new electric street railway company at Seattle, Wash., with a capital stock of $1,000,000, guarantees to run cars into Ballard by next May.

An Electric Elevator Installation.

The illustration on this page is of a hydraulic elevator installation made for the United Security Trust and Safe Deposit Company of Philadelphia. The small space required for every part of this installation is an admirable feature. Messrs. Chadbourne, Hazleton & Co., of Philadelphia, had charge of the work for the Sprague Motor Company. Before the installation of the electric motor a gas engine had been used to supply the necessary power. The pump was manufactured by the Otis Elevator Company especially for the plant. The motor operates the pump against a pressure in the tank; there is no overflow, and when the maximum pressure is reached the motor runs empty, automatically cutting down the amount of electric current taken from the line, so that only that used to keep the motor in revolution is used. The motor is giving the finest satisfaction.



ELECTRIC POWER FOR ELEVATOR PUMP.

Cleveland's Electric Cars.

One year ago, the first electric motor car, run by the overhead system, made its trial trip at Cleveland, Ohio. Since that time the system has assumed proportions of great magnitude. The East Cleveland Company has 40 electric motors in service, all of them of twice the horse-power that they originally used. The cars are running 5,000 miles per day and reducing the running time per trip at least one-fifth as compared with horse-power a year ago and affording 33 per cent. more seating room than at that time. The company has erected wires over 32 miles of track, and would ere this have had all the wires in service had it been possible to secure the necessary motors. Notwithstanding the popular impressions as to the dangers of electrical transit, the operation of the cars for the past year has tended to prove their greater safety in comparison with horse car service, a less number of persons having been injured by being run over than during the previous year when operating by horse-power.

Test of Sprague Motor Car at Reading, Pennsylvania.

The test of the Sprague motor car, made at Reading, Pa., on the 19th ult., not only proved highly satisfactory, but surpassed the expectations of the experienced gentlemen in whose presence the examination was made.

The exhibition was in charge of Messrs. Stadelman and McLure, of the Sprague Motor Company, and Mr. Scholl, superintendent of the East Reading railroad, and was given through the kindness of A. J. Brumbach, president of the company.

The car used for the test is a recent purchase of the company, having the improved truck and being equipped with the new "Boston" motor. The "Boston" is a double motor, so regulated that a cut-out under the seat of the car makes it possible to operate one or both. Each motor weighs about 1,500 pounds, and the entire car 8,500, which is geared to run 15 miles per hour on a level.

The first run was made from 19th and Perkiomen avenue to the summit with one motor. Then the two were put into operation and the car was sent back at full speed down the eight per cent. grade to the center, or what is known as the 40 foot portion of the curve at 19th and Fairview, where the grade is eight and a half per cent. At this point, the worst on the road, the current was reversed, the car stopped instantly and flew back up the hill again. This experiment was repeated over a dozen times, and was pronounced by the electricians present the most severe ever attempted with any motor, yet in each case the result was the same—complete success.

Mr. Stadelman, who had charge of the switch then gave exhibitions of starting and stopping on a level and while going up a grade, of running down without brakes, controlling the car with the current, and of skidding the car along the tracks. All were equally satisfactory, and so were other tests.

* * The contract for street lighting for a term of five years at Rockland, Me., has been transferred to the Eastern Electric Construction Company, of Portland, who have purchased the gas company and electric company, and will unite both companies under one management. They will build suitable buildings on vacant land of the gas company for arc, incandescent and electric power station and extend the system to Thomaston. F. A. Sawyer, treasurer of the Construction Company, will be treasurer and manager.

* * The Aldermen of Indianapolis have adopted an electric railway ordinance. One section of the ordinance is of interest just now, owing to the conflict existing in some sections between the electric railway and telephone interests. It is as follows: "That if electricity is adopted, and the overhead system used, then the Citizens' Street Railroad Company shall place iron poles between their double tracks and suspend the wires from an arm on the said poles, and the said poles, wires and fixtures shall be so placed and maintained as not to interfere with the reasonable and proper use of existing telephone wires."

IN FAVOR OF BRUSH.

THE DOUBLE-CARBON ARC LAMP DECLARED BY JUDGE GRESHAM TO BE THE INVENTION OF CHAS. F. BRUSH.

In the Circuit Court of the United States for the district of Indiana, Judge Gresham on December 24th decided the case of the Brush Electric Company *vs.* the Fort Wayne Electric Light Company *et al.* The decision, being an important one, is published in full below, and is in favor of Mr. Brush:

GRESHAM, *J.*

This suit is brought for an alleged infringement of Letters Patent No. 219,208, granted to Charles F. Brush, September 2, 1879, for improvement in double-carbon electric lamps of the arc type. Brush assigned the patent to complainant before suit was brought.

When two ordinary pointed carbon sticks are in contact in an electric current the circuit is closed, and the current freely passes through the carbons without the production of any appreciable amount of heat or light at the point of contact. If, however, while the electric current is passing through them the carbons are slightly separated, the current will continue to flow in, crossing or leaping the small space between the separated carbon points, and intense heat and light will be produced. This is known as the electric arc lamp, and the one generally used for illuminating large buildings and halls, and for lighting streets. The incandescent electric light is produced by causing a current of electricity to pass through a filament in a glass bulb from which the air has been exhausted. In its passage the current encounters great resistance, and as a consequence it is heated to a degree producing a bright, white light throughout its entire length. This light is well adapted to use indoors.

As early as 1810 Sir Humprey Davy, with a battery of 2,000 cells, succeeded in producing an arc light between two horizontal charcoal pencils, insulated, except a small portion at their ends, but owing to the rapid combustion of the soft charcoal points, and the great cost of the battery, and the short duration of the light, it was of no practical or commercial value. But little progress was made in the improvement of this arc light or lamp until 1844, when Foucault substituted pencils made of a hard gas carbon for the charcoal pencils of Davy, and thereby for the first time produced a persistent but short-lived electric arc light. By a clockwork mechanism Foucault fed the carbon pencils toward each other so as to imperfectly regulate their burning away and maintain the arc. The voltaic battery did not generate electricity on a sufficiently large scale, the light was expensive, and it did not go into general use.

Later the dynamo electric machine was developed in which a powerful current of electricity was produced by revolving coils of wire in a field of magnetic force furnished by powerful permanent magnets, after which the arc electric light was successfully used in lighthouses in England, and later (1867) in France. But up to this time no means had been devised for producing an adequate current of electricity for illumination at a practicable cost, and it was not until the invention of the Gramme dynamo electric machine in 1872, that electricity was produced in a manner and of sufficient strength to render electric lighting practical and useful. This machine was afterwards improved in details of construction. In this state of the art, Brush entered the field of invention, and on May 7th, 1878, obtained patent No. 203,412, for his arc lamp, which was superior to any lamp that had preceded it. This lamp, however, was not capable of burning continuously more than eight or ten hours, and when used for all night lighting it was necessary to extinguish the light and renew the carbons; and in order to obviate this defect Brush invented the lamp in suit. The invention and the means by which it is carried out are thus described in this specification:

"My invention relates to electric lamps or light regulators, and it consists, first, in a lamp having two or more sets of carbons adapted, by any suitable means, to burn successively—that is, one set after another; second, in a lamp having two or more sets of carbons, each set adapted to move independently in burning and feeding; third, in a lamp having two or more sets of carbons adapted each to have independent movements, and each operated

and influenced by the same electric current; fourth, in a lamp having two or more sets of carbons, said carbons by any suitable means being adapted to be separated dissimultaneously, whereby the voltaic arc between but a single set of carbons is produced; fifth, in the combination, with one of the carbons or carbon holders of a lamp employing two or more sets of carbons, as above mentioned, of a suitable collar, tube, or extended support, within or upon which the carbon or carbon-holder to which it is applied shall rest and be supported.

"I desire to state at the outstart that my invention is not limited in its application to any specific form of lamp. It may be used it any form of voltaic arc light regulator, and would need but a mere modification in mechanical form to be adaptable to an indefinite variety of the present forms of electric lamps.

"My invention comprehends broadly, any lamp or light regulator where more than one set of carbons are employed, wherein—say in a lamp having two sets of carbons—one set of carbons will separate before the other. For the purpose merely of showing and explaining the principles of operation and use of my invention, I shall describe it in the form shown in the drawings as applied to an electric lamp of the general type shown in the United States Letters Patent No. 203,411, granted to me May 7, 1879, reissued May 20, 1879, and numbered 8,718. The leading feature of this type of regulator is that the carbon holder is a rod or tube which slides through or past a friction clutch, which clutch is operated upon to grasp and move said carbon rod or holder, and thus to separate the carbons and produce the voltaic arc light; and I shall refer to such a lamp in my following description.

"*A* represents one set of carbons, *A'* another set, each carbon having an independent holder *BB'*. The carbon holders *BB'* may either be in the form of a rod or tube, and each of them is made to pass through a clamping and lifting device *CC'* respectively. These clamps and lifters *CC'* are shown in the present instance in the shape of rings surrounding their respective carbon holders *BB'*. This form, while I have found it for general purposes the best, is not necessarily the only form of clamp that may be used in carrying out my present invention. Each ring clamp *CC'* is adapted to be lifted from a single point, thus tilting it and causing it to grasp and lift its enclosed carbon holder. This tilting and lifting movement is imparted to the clamps *CC'* by any suitable lifter *D*, and this lifter may have its movement imparted either by magnetic attraction due to the current operating the lamp, or by the expansive action of heat upon any suitable apparatus connected with the lamp, said heat generated by the electric current operating the lamp.

"I do not in any degree limit myself to any specific method or mechanism for lifting, moving or separating the carbon points or their holders, so long as the peculiar functions and results hereinafter to be specified shall be accomplished. The lifter *D* in the present instance, is so formed that when it is raised it shall not operate upon the clamps *CC'* simultaneously, but shall act upon one and then the other, (preferably the clamp *C* first and *C'* second, for reasons which shall hereinafter appear.) This function or dissimultaneous action upon the carbons or their holders, whereby one set of carbons shall be separated in advance of the other, constitutes the principal and most important feature of my present invention. In the lamp shown in the drawings the lifter *D* is actuated and controlled through the agency of magnetic attraction due to the influence of the current operating the lamp, and this is accomplished as follows: One, two or more spools or hollow helices, *E*, of insulated wire are placed in the circuit, within whose cavities freely move cores *E'*. The electric current passing through the helices *E* operate to strongly attract within their cavities their respective cores *E'* in the same manner as specified in my former patent above refered to. The cores *E'* are rigidly atttched to a common bar, E2, and the upward and downward movement of this bar, due to the varying attraction of the helices *E*, is imparted by a suitable link and lever connection *E3*, *E4*, to the lifter *D*. By this connection the lifter will have an up and down movement in exact concert with the c res *E'*; and it is apparent that this connection between magnet and lifter may be indefinitely varied without any departure from my invention; and therefore while preferring for many purposes the construction just specified, I do not propose to limit myself to its use.

"The lifter *D* may be so constructed and operated as to separate the carbons *A* and *A'* successively or dissimultaneously by being so balanced that any difference, however slight, between the weights of the carbon *AA'*, or their holders *BB'*, shall result in one being lifted and separated before the other.

"In order properly to balance the attractive force of the magnets, a coil-spring *F*, or its equivalent, may be employed, substantially as shown, and to insure a steady motion to the magnets and to the carbon points *AA'* a dash pot *G*, or its equivalent, should be employed, as this prevents any too sudden abrupt or excessive movement of parts.

"*HH'* are metallic cables through which the current is conducted from above to the clamps *CC'* and the carbons *AA'*. By this provision is not only insured a good connection between the upper carbon points and the mechanism above it, but another important advantage is obtained, and that is the prevention of sparks due to any interruption of the current between the carbon-holder *BB'* and its clamp or bearings. This spark, if occurring too frequently, is liable to burn and roughen the rods *BB'* or their bearings or clamps, and thereby render their operation uncertain, because it is important that a free movement to any degree, however minute, may be allowed the carbon-holder. These cables *HH'* while operating as just specified, are sufficiently flexible and yielding not to interfere with any movement of their respective carbons or carbon-holders.

"The operation of my device, as thus far specified, is as follows: When the current is not passing through the lamp, the positive and negative carbons of each set *AA'* are in actual contact. When, now, a current is passed through the lamp, the magnetic attraction of the helices *E* will operate to lift the lifter *D*. This lifter, operating upon the clamps *C* and *C'* tilts them and causes them to clamp and lift the carbon-holders *BB'*, and thus separate the carbons and produce the voltaic arc light, but it will be especially noticed that the lifting and separation of these carbons is not simultaneous. One pair is separated before the other, it matters not how little nor how short a time before. This separation breaks the circuit at that point, and the entire current is now passing through the unseparated pair of carbons *A'*, and now and then the lifter, continuing to rise, separates these points, the voltaic arc will be established between them and the light thus produced.

"It will be apparent by the foregoing that it is impossible that both pairs of carbons *AA'* should burn at once, for any inequality of weight or balance between them would result in one pair being separated before the other, and the voltaic arc would appear between the last separated pair. This function, so far as I am aware, has never been accomplished by any previous invention, and by thus being able to burn independently and one at a time two or more carbons in a single lamp, it is evident that a light may be constantly maintained for a prolonged period without replacing the carbons or other manual interference. In the form of the lamp shown I can, with 12-inch carbons, maintain a steady and reliable light without any manual interference whatever for a period varying from 14 to 20 hours.

"It is for some reason desirable that one set of carbons—say the set *AA*—should be consumed before the other set commences to burn, although it is not essential, in carrying out my invention, that the carbons should be consumed in this manner, inasmuch as, if desirable, they may be arranged to burn alternately instead of successively. It is apparent however if one set of carbons can be made to entirely consume before another set begins to burn, that there will be less interruption of the light than if the different pairs were allowed to consume in frequent alternation. I have therefore shown, in the present invention, one method of arboring a consumption of one set of carbons before another shall begin to burn. This I accomplish through any suitable support *K*, and in such a construction of the lifter *D* that it shall be positive in its function of separating one set of carbons before the other; or in case where more than two sets of carbons are employed to separate said sets successively.

"In the lamp as shown in the drawings the support *K* is in the form of a tube surrounding the carbon holder *B*, and this support *K* is made of such a length that when the carbons *A'* shall have been sufficiently consumed, a head upon the carbon holder *B* will rest upon the top of the support *K*, whereby the weight of the carbon holder *B* and its support *K* shall at all times and under any circumstances be supported by the lifter *D*.

"Besides the carbon holder *B*, with its carbon, and the support *K*, the lifter *D* (when the lamp is in operation) should also be made to carry the carbon holder *B'* and its carbon.

"The lamp is primarily adjusted so that the magnets through the lifter *D* shall always carry a definite load, to-wit, (in the form shown,) the carbon holders *B* and *B'* and support *K*. The desirability of this construction and arrangement may be explained as follows: Supposing, as is designed in the present instance, the carbons *A* are first consumed. During this time, of course, the magnets are lifting both carbon holders *BB'*. Now, when the carbons *A* are consumed, if no provision be made to the contrary, the carbon holder *B* would not be lifted during the consumption of the carbons *A'*, and this diminishment of the weight carried by the magnets would be liable to materially disturb the adjustment of the lamp and impair its operation accordingly. To obviate this difficulty I have provided the support *K*, by which provision the magnets shall be made to carry the carbon holder *BB'* and the support *K*. The difference in weight, owing to the consumption of the carbons, is a practically unimportant matter, and does not materially interfere with the operation of the lamp.

"In the case of a lamp where the carbon holders *BB'* are very light, and where the weight of one might be relieved from the magnet (or other motive agent) without material disturbance, the support *K* might be dispensed with. Said support *K* might also be omitted, if desired, in a lamp where the lifter is actuated through the agency of the expansion of the metal wire or bar by the action of heat generated by the current operating the lamp, inasmuch as the force due to said expansion being practically irresistible, it would not be necessary to obtain a balance between various parts as is the case with a lamp as shown in the drawings.

"Thus far I have mentioned but two ways of imparting dissimultaneous motion to the carbons of an electric lamp, viz: through magnetic attraction and through the expansive action of heat. This function of my device may be accomplished by clock work or equivalent mechanical contrivance; and in this respect, as before stated, I do not limit my invention.

"*LL'* are metallic hoods or protectors for inclosing and shielding the upper projecting ends of the carbon holders *BB'*.

"In the form of lamp shown in the drawing, I obtain very satisfactory results by constructing the helices *E* according to letters patent No. 212,183, granted to me February 11, 1879. In each helix *E* two independent wires surround the lifting magnets *E'*, one of fine and one of coarse wire, and each placed in the general circuit operating the lamp. These two wires (the fine and coarse) are constructed and connected in such a manner as to carry current in opposite direction around the inclosed core, thus exerting a neutralizing influence upon each other, whereby a governing function is secured for a better description and understanding, of which reference is made to said patent No. 212,183.

"The poles of the lamp shown in the drawings are constructed in the form of depending hoops or loops, from which the lamp is suspended, and the corresponding hoops or loops, with which they engage in the ceiling (or other locality where the lamps are used) are the positive and negative poles of the current generating apparatus. Thus, by the simple act of suspension, the lamp is placed in circuit.

"I will now specify a construction whereby the protecting globe surrounding the light can be raised and lowered for convenience in renewing carbons and handling the lamp. This I accomplish by making the platform or gallery 0, upon which the globe rests, vertically adjustable upon a rod *0'*, attached to the lamp; this may be conveniently manner. A set screw should be provided, whereby the globe can be adjusted to any d sired position. By this arrangement the work of renewing carbons and the reliable adjustment of the globe in relation to the voltaic arc materially assisted.

"In order to accommodate long sticks of carbon, the platform or gallery 0 should be perforated to allow passage down through it of said carbon sticks. I prefer making the platform or gallery 0 of metal, and of such shape as that globules of molten copper from the coverings of the carbons, in dropping away, shall not escape to do damage.

"It will be particularly observed that in the form of dash-pot employed the cylinder is the movable and the piston or plunger the stationary element. This construction implies more than a mere reversal of the usual make and operation of the dash-pot, for by making the cylinder the movable element the general construction of a lamp can very often be materially simplified as in the present instance. This form of dash-pot is designed to be employed in connection with any of the working parts of the mechanism of an electric lamp where it is desired to retard a downward movement."

The lamp covered by patent No. 203,411 is referred to only for the purpose of illustrating the operation of the invention in suit, and the complainants right to the relief prayed for does not depend upon the validity of that patent. The lower carbon of this lamp is held in a fixed position and its upper carbon is carried by a sliding rod which passes through a ring clamp just large enough to permit it to slide freely through when the clamp lies flat on the floor of the regulator case, but which binds upon the rod when it is lifted by one edge. The lifter which is upon the edge of the clamp is attached to a soft iron core which plays inside a wire helix, through which the current produces the light circulates. The attracting strength of this coil is proportionate to the strength of the current flowing through it. When there is no current flowing through the lamp, the coil has no attraction at all, and the core consequently rests at the lowest limit and the ring clamp lies flat on its floor. In that situation the carbon rod slips freely through the clamp and the upper carbon rests in contact with the lower one.

Upon the establishment of the current through the lamp it passes through the carbons with little resistance because they are in actual contact. The circuit is, therefore, a strong one and energizes the coil strongly, and it in turn attracts the core strongly and pulls it downward. This movement being communicated to the lifter, it, in turn, first lifts the ring clamp by one edge; this causes it to impinge closely upon the rod, and then lifts the rod and carbon, and so separates the carbon points. This establishes the arc. But the arc introduces a resistance to the current which diminishes its strength, the resistance increasing as the arc grows longer. Hence, as the arc lengthens by the consumption of the carbons and the increase of the space between them, the current grows weaker, and the attracting power of the coil diminishes until it lets the core move downward sufficiently to release the grasp of the clamp on the rod, so that it slips downward. As the upper carbon approaches the lower, and so shortens the arc and diminishes its resistance, the current's strength increases, the coil again pulls the core upward and so tightens the clamp upon the rod, and this holds the upper carbon suspended at its normal distance from the lower. This process goes on until the carbons are consumed.

It will be observed from the description of the lamp in suit that when the current is first passed through it, the current divides at the lamp and passes through both pairs of carbons and instantly energizing the solenoids, draws upwardly the cores, and through the bar *E*, link *E*, lever *E* and lifter *D*, separates the pairs. The unlikelihood of the separation of this pair of carbons does not operate to break the circuit and form an arc between them, but simply diverts the entire current through the remaining and unseparated pair of carbons *A*. The lifter *D*, continuing to rise next separates the carbons *A*, thereby interrupting the circuit and establishing the arc between the last separated pair of carbons *A'*. After the arc has been established between one pair, the carbons of the remaining pair are held separated by the ring clamp, their initial separation being such that the idle pair will be retained in their separated relation, while the regulator automatically moves and adjusts the burning pair, to separate or approximate them, as the conditions may require to regulate the length of the arc, and also to automatically feed them to maintain the arc. When the burning pair of carbons has been consumed, the effective pull of the solenoids is diminished to such an extent that the carbons of the idle pair are brought into contact, which causes the entire circuit to be instantly diverted through them, the effect of which is to strengthen the solenoids and separate the carbons and automatically establish the arc between them.

The separation of the two pair of carbons, so that the arc is established between one pair and maintained between the carbons of that pair until they have been consumed, and then automatically established between the carbons of the other pair and maintained between them until they have been consumed, is a dissimultaneous and successive arc-forming separation, and it is this feature which distinguishes the lamp in suit from all prior lamps.

The six claims of the patent which it is alleged are infringed read:

"1. In an electric lamp two or more pairs or sets of carbons, in combination with mechanism constructed to separate said pairs dissimultaneously or successively, substantially as and for the purpose specified.

"2. In an electric lamp, two or more pairs or sets of carbons, in combination with mechanism constructed to separate said pairs dissimultaneously or successively and establish the electric arc between the members of but one pair (to wit: the pair last separated), while the members of the remaining pair or pairs are maintained in a separated relation, substantially as shown.

"3 In an electric lamp having more than one pair or set of carbons, the combination, with said carbon sets or pairs, of mechanism constructed to impart to them dissimultaneous and dissimultaneously separating and feeding movements, whereby the electric light will be established between the members of but one of said pairs or sets at a time, while the members of the remaining pair or pairs are maintained in a separate relation, substantially as shown.

"4. In a single electric lamp, two or more pairs or sets of carbons, all placed in circuit so that when their members are in contact the current may pass freely through all said pairs alike, in combination with mechanism constructed to separate said pairs dissimultaneously or successively, substantially as and for the purpose shown.

"5. In an electric lamp wherein more than one set or pairs of carbons are employed, the lifter, *D*, or its equivalent, moved by any suitable means, and constructed to act upon said carbons or carbon holders dissimultaneously or successively and substantially as and for the purpose shown.

"6. In an electric lamp wherein more than one pair or set of carbons are employed, a clamp, *C*, or its equivalent, for each said pair or set, said clamp, *C*, adapted to grasp and move said carbons or carbon holders dissimultaneously or successively, substantially as and for the purpose shown."

It is admitted by the defendants' counsel that the patent in suit describes a new and useful mechanism for which Brush was entitled to a patent, but it is urged that the second, third and fourth claims are for functions or results without regard to mechanism, and are, therefore, void.

The claims are not open to this objection. The specification describes mechanism whereby a result may be accomplished, and the claims are not for mere functions, nor fairly construed, can it be said that they cover other mechanism employed to perform the same functions. The first claim, construed in connection with the means described in the specification, is for an arc lamp, in which two or more pairs of carbons are used, the adjustable carbons or each pair being independently regulated by one and the same mechanism, and in which there is a dissimultaneous or successive separation of the pairs, so as effectually to secure the continuous burning of one pair prior to the establishment of the arc between the other pair. Thus construed the invention claimed is limited to the particular means described in the specification and their substantial equivalents.

The second, third and fourth claims also refer to the specification for the accomplishment of results covered by these claims. They are for combinations of specific mechanisms, and their substantial equivalents, and not for results irrespective of means for their accomplishment.

It is true that in the specification Brush declared, "I do not in any degree limit myself to any specific method or mechanism for lifting, moving or separating the carbon points, or their holders, so long as the particular functions and results hereinafter to be specified shall be accomplished."

He did not say, however, that he claimed all mechanisms irrespective of their construction and modes of operation By this language he simply notified the public that he did not restrict himself to the particular lamp described in the patent, but that his invention embraced *that* and all other lamps operated substantially the same way by equivalent mechanism.

It is urged that the fifth claim covers the lifter simply, and that the sixth claim covers nothing but the clamps, and being so only for detached parts of the lamp, incapable of separately performing the functions ascribed to them, and these claims are void.

The fifth claim is for a combination of which the lifter *D* is an element, and thus construed, the claim is for a novel and useful invention.

The sixth claim is not for the two clamps aside from other connected mechanism. It is for the two clamps in combination with the mechanism described in the patent for actuating the clamps and causing them to grasp and move the carbons dissimultaneously, substantially as and for the purpose described in the specification.

Patent No. 147,827, issued to Matthias Day, Jr., February 24, 1874, is relied on as an anticipation of the first, second and fourth claims of the patent in suit. This defense is based upon a construction of these claims that gives no effect to their concluding restrictive language, which construction, we have seen, is not authorized. The patent in suit describes mechanism which designedly and positively effects a dissimultaneous separation of the carbons and Professor Barker, the defendants' expert, testified that the Day lamp was not so constructed, and did not so operate It is true that the Day patent describes a lamp which contains two or more pairs of carbons, but not such a double carbon lamp as Brush invented. In the Day lamp each carbon is split or divided vertically for a slight d istance from the outer end, but so rigidly connected at the clamp extremity as to act solely as a pair of separate carbons, and not as "two or more independent pairs or sets of carbons."

Owing to the constant and frequent shifting of the arc from one pair of carbons to the other, in this lamp it produced an irregular and unsatisfactory light. It was unlike the Brush lamp, both in construction and mode of operation.

The answer also denies infringement, but that defense, like the last one, is based on the theory that the claims are not at all limited by their concluding language. It is plain from the evidence that the defendants' lamp was designedly constructed so as to insure the dissimultaneous separation of the two pairs of carbons for the purpose of forming the arc between one pair only of the carbons, and that both lamps operate in identically the same way and for the same purpose. The patent describes a ring clamp and the defendants use a hinged clamp, but there is not the slightest functional difference between them. Both operate by grasping and holding with varying pressure the smooth rod which carries the carbons, thus allowing the rod to slide so as to secure a continuous feed by inappreciable degrees, while, under other conditions, the cord is allowed to slip suddenly by gravity. The ring clamp was old, and Brush simply employed it as suitable for his purpose in combination with other elements with which it co acts, or the substitution of the hinged clamp, without any change in the mode of operation or function, did not change the combination.

In the Brush lamp the clamps rest on a flat floor, and the arms of the lifter are of unequal length so that when the lifter is raised, one clamp is tilted in advance of the other, and the carbons are separated dissimultaneously. In the defendants' lamp the same result is accomplished by supporting the clamps in different planes and employing a lifter with arms of the same length, so that in the operation of the lifter it will tilt one clamp in advance of the other. Brush did not claim that there was invention in the lifter and clamps when connected with other parts in the operation of the lamp, and the defendants cannot escape infringement by showing that they use a lifter and clamps not identical in construction with the lifter and clamps described in the patent. It is admitted that, if the claims are construed as embracing the mechanism described in the specification, the defendants use a lamp covered by the patent in suit, and that renders a further description of defendants' lamp unnecessary.

It is finally contended that, while the patent describes particular mechanism by which the functions stated in the claims can be performed, the patentee expressly declared in his specification that he did not limit himself to this mechanism, or its equivalent, but claimed that his invention comprehended all means capable of accomplishing the results stated, and that having thus claimed more than he was entitled to, the complainant cannot recover until he disclaims everything in the specification except the spec fic mechanism.

An application for letters patent is accompanied by a specification giving a full, general description of the alleged invention, and this is followed by what is known and well understood in the courts, as well as the Patent Office, as a "claim." What the patentee invents and describes in his specification, but fails to embrace in his claim, he abandons to the public, unless by timely application he obtains a reissue for it, and if in the descriptive part of his invention he inadvertently, or otherwise, includes as a part of his invention that which is old, but does not claim it, his claim is not thereby invalidated. Such part of the specification is surplusage. It is only when the claim following the specification is too broad, in the sense of embracing something an new, which is not new that the patentee is required by section 4922 to disclaim. He is not required to disclaim anything in the specification not covered by his claim. The word "specification" is obviously used in the first clause of section 4922 as synonymous with "claim." I am aware of no decision holding that a patentee is required to disclaim anything in the descriptive part of his invention which is not fairly embraced within his claim.

In Railroad Company *vs.* Mellem, 104 U. S., 118, the court said: "In view, therefore, of the statute, the practice of the Patent Office and the decisions of this court, we think that the scope of letters patent should be limited to the invention covered by the claim, and that, though the specification be illustrated, it cannot be enlarged by the language used in other parts of the specification. We are, therefore, justified in looking to the 'claim' with which the specification of the appellee's invention concludes to determine what is covered by this letters patent."

It is not material for the purpose of this suit whether Brush was a pioneer or a mere improver. It is sufficient that he described and illustrated in the patent in suit a specific mechanism, or double carbon lamp, adapted to burn its carbons independently and successively; that he was the first to accomplish this result, and that the claims are for mechanism substantially as described in the patent in combination with two or more pairs of carbons or sets of carbons for producing the result specified. We have already stated that what is claimed is not functions and results, but mechanism for producing functions and results.

A decree will be entered in accordance with the prayer of the bill.

R. S. Taylor, For defendant. M. D. Leggett & L. L. Leggett, H. A. Seymour, For complainant.

The tower system of electric lighting, which has been in use at Savannah, Ga., will be virtually abandoned and substituted by the ordinary system. One hundred additional arc lights will be placed.

Three of the largest dynamos ever turned out by the Eddy Company are now being made at Windsor, Conn. When completed they will weigh 7,000 pounds each and are of 45 horse-power. They are to be used for the deposition of copper.

KINDRED INTERESTS

J. H. Bunnell & Co. are now located in their handsome new offices and warerooms at 74 Cortlandt street. No better lighted or more convenient offices are in the city, and these enterprising electrical manufacturers are to be congratulated on securing such a desirable location.

The Rodney Hunt Machine Company, of Orange, Mass., is doing a large and lucrative business in water wheels for operating electric light plants where water power is available. Quite recently this company shipped a carload of machinery to Guatemala, South America, for an electric light plant.

The United Edison Manufacturing Company, New York, has just closed a contract for an isolated plant for Wise Bros. Company, Baltimore. The plant consists of 400 lights, and will be installed and all supplies furnished by the Edison Company. The Washington and Georgetown Road is to have its power station lighted by the same company.

The Burlington Route to the West, Northwest and Southwest.—No other railroad has through car lines of its own from Chicago, Peoria and St. Louis to St. Paul and Minneapolis, to Council Bluffs and Omaha, to Denver and Cheyenne, and to Kansas City and St. Joseph. Tickets via the Burlington route can be obtained of any ticket agent of its own or connecting lines.

The Pond Engineering Company have shipped a 150 horse-power Armington & Sims engine to the Edison Electric Illuminating Company of New Orleans, making the sixth engine furnished them. The Pond Engineering Company are furnishing a fifty horse-power boiler for the ice factory at Corpus Christi, Tex., an automatic feed pump and receiver in Kansas City, and leather link belt to the Holden, Mo., electric plant and the St. Louis Smelting and Refining Company.

The Chicago, St. Paul and Kansas City Railway Company, through its passenger agent, Mr. W. R. Busenbark, whom telephone men will remember as having done so much toward making their convention trip from Chicago to Minneapolis one of pleasure and comfort, has just adopted a new trade mark. The design was executed by Mr. R. G. Thompson, passenger and ticket agent of the Wabash Railway at Ft. Wayne, Ind. It consists of a typical leaf of the sugar maple, upon which are clearly shown the lines of the company, connecting Chicago with St. Paul and Kansas City.

The Westinghouse Machine Company calls October, 1889, its "red letter month," and well it may, judging from the list of sales recorded. The summary for the month is as follows:

Compound—
45 engines, aggregating 3,575 h.p.; av. 80 h.p.
Standard—
32 engines, aggregating 1,395 h.p.; av. 43 h.p.
Junior—
32 engines, aggregating 970 h.p.; av. 30 h.p.
T'tal 109 engines, aggregating 5,940 h.p.; av. 54 h.p.

A later statement just to hand, beats October, and November easily carries off the honors in horse power, as the following shows, and was the heaviest month's business in the history of the company, a great many of the orders going to electric light stations:

Compound—
39 engines, aggregating 5,300 h.p.; av. 136 h.p.
Standard—
31 engines, aggregating 940 h.p.; av. 30 h.p.
Junior—
34 engines, aggregating 940 h.p.; av. 28 h.p.
T'tal 104 engines, aggregating 7,180 h.p.; av. 70 h.p.

Water and Oil Separator.

The illustrations on this page show Barnard's improved separator for removing entrained or condense water from live steam, and condense water, oil, etc., from exhaust steam, and will interest the central station superintendents. Separators are rapidly becoming better known and appreciated; long steam pipes—often times uncovered—necessarily condense considerable steam into water; boilers frequently prime and carry more or less water along with the steam; no matter what may cause the presence of water in live steam pipes, the fact that it is there is a sufficient reason for removing it from the pipe before the steam reaches the engine. Entrained water is an absorbent of heat; it is incapable of performing work in the cylinder, and very liable to wreck an engine or pump, as has frequently occurred. A good separator furnishes practically dry steam, that is, saturated steam without entrained water. The value of dry steam is fully appreciated by engineers, if not by coal dealers.

By separating the oil or greese from the exhaust steam, that after condensation (either in a surface condenser or steam heating coils) is used for boiler feed water; the greatest source of expense and labor attending the care and efficiency of boilers is removed. The effect on surface condensers, vacuum pans, feed-water heaters, steam heating pipes, etc., is equally beneficial, as the cleanly and purified condition of the steam admits of no coating of surfaces, or formation of dirt or scale.

The design and construction of this separator is of a character that presents a very large and effectual separating surface, together with a liberal port area for the unobstructed passage of steam through the plates, considerably in excess of the area of the connecting pipes.

It consists of a cylindrical shell of cast iron for the smaller sizes, and of plate iron or steel, for the larger sizes, fitted with a sloping channel way, open to the shell. The baffle plates are set at an angle, and are supported by rings fitting the shell. The plates of one ring cover the ports of the next, thus compelling the steam to take a tortuous course through the shell. The oil or water coming in contact with the bars and rings, runs down through cored holes at the bottom of the bars into the sloping pocket to the discharge pipe at bottom, where it is drained off. See cuts 2, 3 and 4.

For use on vertical pipes, a different arrangement of rings and plates are used from those shown in our illustration. The effect is practically the same, but all things considered, horizontal separators are generally to be preferred.

The cut, Fig. 1, shows a special device that will interest engineers and others using surface condensers. It is well known that the vacuum extending from the condenser to the engine cylinder will "hold up" the condense water and oil collected by a separator; in fact, a separator ordinarily used under such conditions is practically useless.

The device shown, consists in connecting the waste pipe from the separator to the suction chamber of a pump, and in connecting a second, or vacuum pipe, fitted with suitable check valves, to the suction chamber, above the suction valves. This places the suction valves of the pump in equilibrium, and enables the pump to continuously draw off the oil and water. The efficiency of this separating device, is such, that no filtering tank is needed, other than the ordinary hot well, which may be of limited capacity sufficient to afford solid water for the boiler feed pumps to draw on.

When the separator is used on live steam pipes, the estopped water should be returned directly to the boilers as a matter of economy. The conditions of each plant will determine the best method to be employed for so returning the hot water.

When used on exhaust pipes of non-condensing engines, the condense water and oil may be delivered into a tank if it is desirable to save and filter the oil for further use; if not, then it may be discharged into a sewer, or otherwise disposed of.

The patentee and manufacturer is Geo. A. Barnard, 15 Cortlandt street, New York City, a gentleman well known in engineering circles.

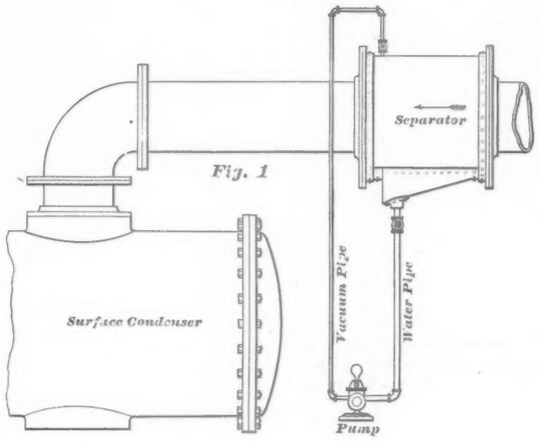


Fig. 1

Electric Lighting in Oregon.

The Westinghouse Electric Company closed a contract with the Willamette Falls Electric Company of Portland, Oregon, on the 19th of last month, the specifications of which contain some very unique features.

The Portland corporation intends to light up the streets and houses of that city, and they are going to establish a central station plant and equip the same with Westinghouse alternating current machinery for a capacity of 6,000 incandescent and 100 arc lamps. The central station it is proposed to erect at Willamette Falls, a distance of 12 miles from Portland, because the company wants to utilize water power in the generation of the electric current. From the station the current is to be carried to a branch station in the city and from here it is to be distributed.

Owing to the long distance the current is to be carried previous to its distribution, the Westinghouse Company will make a special kind of apparatus for this plant capable of generating a current of 4,000 volts. The arc light machine chosen by the Portland Company is of the newly brought out arc light system of the company, and the entire number of lights is to be run from one machine.

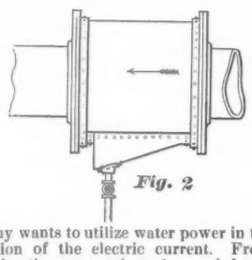


Fig. 2

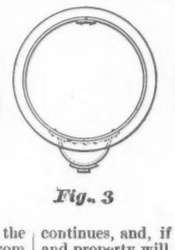


Fig. 3

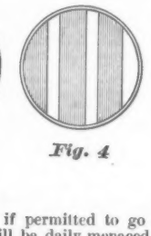


Fig. 4

Train Lighting.

The lighting of trains by electricity is fast coming into general use, and rapid strides in this direction are being made by many roads. Two of the finest and most perfectly equipped trains are now run on the Mormon route from Chicago to Indianapolis, Dayton, Cincinnati and the South.

The train over this road, leaving Chicago daily at 9.30 P.M. is so complete in this respect that it has been appropriately named "the Electric." It is vestibuled, and composed of Pullman parlor and sleeping cars and day coaches, and is heated by steam from the engine, lighted by incandescent light, and has a complete annunciator system throughout.

Electric Light Superintendent Indicted.

Friday of last week the Grand Jury, of this city, found an indictment against Charles W. Pierce, superintendent of the Brush Electric Illuminating Company, of this city, charging him with manslaughter in causing the death of Henry Harris, a clerk in a dry good store at 675 Eighth avenue. This occurred the evening of November 30, at which time Harris and another clerk named Hughes were carrying a show case from the sidewalk into the store, when the show case came in contact with an electric arc lamp in front of the store and the shock Harris received is supposed to have caused his death.

As this is the first indictment ever found in this country for causing death by electricity, it is interesting to note how it is worded. It contains two counts. The first charges that Pierce made an assault on Henry Harris, "and a current of electricity of great and deadly power and intensity through and into the body of the said Henry Harris did put, place and pass, and caused and procured to be put, placed and passed, and the said current of electricity into the body of him, the said Henry Harris, did wilfully and feloniously keep and continue, and caused and procured to be kept and continued for a space of time, to wit, for the space of five seconds, thereby causing, with the electric current aforesaid, a mortal electric shock, of which said mortal electric shock the said Henry Harris then and there died."

The second count describes the manner in which the Brush Electric Light Company operated its currents, and says that the company had a central station at 210 Elizabeth street, and maintained a number of circuits. One of these circuits was called "Commercial Circuit No. 7," and on that circuit, among other lights, was the light in front of Callen's store. Then the second count of the indictment charges that Pierce was the superintennent of lights of the company, and it was his duty to place the lights so that citizens could pass through the streets or work in the streets without danger.

Mr. Pierce came to the District Attorney's office, and was released on bail of $2,500, President W. T. Moore of the Brush Company qualifying as security.

Foreman Samuel A. Lewis of the Grand Jury also handed up to Judge Gilversleeve a presentment, the result of the Grand Jury's inquiry into the recent deaths of linemen by electricity, and the dangers of electric lighting in the streets. The presentment is as follows:

"The Grand Jury has listened to a great deal of testimony of so called experts in the appliance of electricity for the production of light, many of whom are retained by or interested in the various electric light companies. There was a diversity of opinion among them as to the danger to life and property, and, notwithstanding this, loss of life and the destruction of valuable property continues, and, if permitted to go on, life and property will be daily menaced—a condition of affairs which no adequate plan has yet been devised to prevent.

"It is manifest that legislative action should be invoked at once to provide a means of preventing further casualties by electric currents. It was recently shown to the Supreme Court of the State that wires for the transmission of electricity had been permitted to become in a condition dangerous to human life, so that passers-by, in short, were liable to be struck dead, and therefore that the corporations responsible for this condition of things were conducting a business by means of an apparatus and a force which, unless properly controlled, subjected the citizens of this city to the danger of death. Thereupon the court held the facts constituted a public nuisance, and directed that an injunction previously obtained, restraining the authorities from interfering with these wires, should be vacated and set aside, on the ground that not only the public authorities but any citizen would be justified in abolishing the nuisance. Of this decision the Grand Jury heartily approve. Inasmuch as the authorities are now engaged in removing the dangerous wires and apparatus condemned by the court, the Grand Jury have not deemed it necessary to take action in reference thereto; the result to be accomplished by a criminal indictment for a nuisance—to wit, the abatement of the nuis-

ance—having already been brought about by the decision of the Supreme Court.

"The Grand Jury is convinced that the business of the generation and distribution of electrical currents is one which should be investigated by the Legislature for the purpose of ascertaining the character of legislative enactment required to provide a means for carrying on the same without danger to the public.

"We therefore recommend that the Legislature shall without delay appoint a committee of its members to inquire into the subject and report upon a plan of legislation designed to prevent further danger to the public from electrical apparatus."

A New and Complete Electric Light Station.

Mr. Eugene T. Lynch, Jr., of 120 Broadway, N.Y., consulting and contracting engineer, has secured the contract for the central station plant to be erected at Hampton, Va.

This plant will light Hampton and Elizabeth City, and will also furnish light and power to several institutions in that vicinity, including the National Soldiers' Home, Virginia Normal Schools and Fortress Monroe.

The total number of lights furnished will be 8,100 sixteen candle-power incandescent lamps and fifty 2,000 candle-power arc lights.

This station when complete will be one of the model plants of the South.

Electricity vs. Gas.

In New Orleans, La., on the 15th inst., Justice Poche, as the organ of the Supreme Court, handed down a decision in the case of the New Orleans Gaslight Company vs. City of New Orleans, involving a contract with the Louisiana Electric Company with the city for lighting, affirming the decision of the lower court which was rendered in favor of the Louisiana Electric Light Company.

The court says, "that the plaintiff brings suit in the capacity as a taxpayer for the purpose of setting aside a contract made between the city and the Louisiana Electric Light Company in May, 1887, to light the city by electricity for five years, beginning January 1, 1888. The grounds of attack to be considered on appeal are as follows:

That the contract is null and void, because it violates the prohibition contained in section 2448 of the Revised Statutes, which provides "that police juries of the several and the constituted authorities of incorporated towns and cities in this State shall not hereafter have power to contract any debt or pecuniary liability, without fully providing in the ordinance creating the debt, the means of paying the principal and interest of the debt as contracted. That the city has no power in law to enter into such a contract." The defense is practically a general denial, and the judgment on appeal rejected plaintiff's demand.

The court holds: "A time contract between a municipal corporation and a gas or other lighting company, for a supply of gas or other light, for a number of years, does not evidence the contracting of a debt within the scope and meaning of section 2448 R. S., if it appears that the gas or light to be furnished in the future is to be paid for from month to month.

"A stipulation in the contract by which the city binds herself to make an annual appropriation out of her current revenues, in an amount sufficient to cover the provisions of the contract, is sufficient as a provision to meet the pecuniary liability to be thereby incurred within the requirements of said section 2448 R. S.

"In the absence of a special statutory limitation or restriction, the power given to the city of New Orleans to make contracts for lighting its streets, landings, etc., is sufficient to authorize a contract for more than one year for such commodity. Judgment of the lower court affirmed and in favor of defendants."

Give Us More Light.

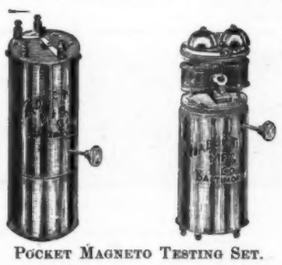
The men who dictate the policy of Tammany Hall have evidently joined hands with the gas companies in an attempt to bankrupt the electric light corporations. While proper attention must be paid to the public safety, the persecution to which the electric light companies are being subjected is doing them an injustice that will surely cause a reaction in their favor. And it will be a hard matter to satisfy the public with flickering gas jets after an experience of the superior illuminating power of an electric current.

Of course, the accidents that have occurred during the past few months have given the gas companies and their political allies an opportunity to denounce the use of electricity for street lighting that has been eagerly seized. Yet in almost every case, such accidents were primarily due to the carelessness of the victim, who, knowing his peril, did not avail himself of the precautions that would have saved him from injury If lineman Feeks, for instance, had worn the rubber gloves that every man engaged in his hazardous avocation should don before he handles even the most innocent-appearing wires, he would still be alive and thousands of people would have been spared a most horrifying spectacle. For such carelessness on the part of employés the electric light companies cannot be justly censured, as the men are fully aware of the dangers that surround them and the precautions that must be taken to insure their safety.

The lighting of our streets by electricity is a necessity. It is no wonder that the public is growling at the gloom that envelops the city streets just at the time when the hours of darkness are longest, and when the most inclement season of the year renders pedestrianism especially unsafe and unpleasant. And the perils that surround the belated citizen from the attacks of lurking highwaymen and sand-baggers in the darkened streets does not add to the agreeableness of the situation. Give us back the electric lights, Messrs. Aldermen!—*N. Y. Dispatch.*

Pocket Magneto Testing Bell.

The Viaduct Manufacturing Company, of Baltimore, have again come to the front with a new pocket magneto bell for inspector's and linemen's use, which is far ahead of anything yet produced in their celebrated special line. It is a full power magneto, ringing through 10,000 ohms resistance, and is put up in a round nickel-plated case, or tube, with a removable top



POCKET MAGNETO TESTING SET.

that unscrews, allowing the bells to be exposed when necessary. The binding posts for the wire and telephone connections are on top. By pressing the button on the side of the case the signal is given, instead of turning a crank This button can be removed when the bell is carried in the pocket.

The Viaduct Manufacturing Company have just erected a new magneto fire alarm system in Dansville, N. Y., consisting of seven street boxes connected with two hook and ladder houses, and it is giving great satisfaction.

They also manufacture a magneto bell that rings by a simple pull down; no crank is used. It is intended to replace electric bells, push buttons, etc., and does away with the objectionable battery.

They appear to be fully alive to the necessities of the industry and are well prepared to supply the demand.

A Sensible Conclusion.

In reference to the proposed removal of electric wires in Cincinnati, Ohio, the *Gazette* says, editorially:

"It will not be reasonable in us to rush into a wild state of excitement and tear down wires, until there are conclusions as to what is to be done when they are down. Because there have been people killed we do not expect to get along without electric lights or electric cars. We must, as far as possible, insist upon faithful construction. A great many people have been killed in Cincinnati by the explosion of steam boilers, but it is not proposed to abandon the use of steam altogether. There have been leakages of gas which have caused the blowing up of houses and destruction of life, but it is not proposed that we shall get along without illuminating gas. Deaths have occurred many times in our streets from runaway horses. It has not been esteemed essential to abolish horses. What we want is the light of science and the application of experience, not the excitement of public alarms and the excitements that lead to violence."

The Southern New England Telephone Company—New Metallic Service.

On and after the first of January, 1890, the Southern New England Telephone Company will make all out of town connections at the New London (Ct.) Exchange, over the new system of metallic circuits, as far as possible, discontinuing the old grounded wire system.

The rates for communications between exchanges in the State will be as follows: Between 7 A. M. and 6 P. M., 25 cents for five minutes or fraction thereof, and between 6 P. M. and 7 A. M., 15 cents for five minutes or fraction.

Subscribers who do a large intertown business are offered a liberal discount by the purchase of extra territorial commutation books, amounting to $20 worth and upwards. These books are good between all points in the State and until used.

The company will very shortly issue a new and complete list of about 100 public stations, throughout the State. These stations are equipped with long distance instruments and are designed for the use of non-subscribers, who can hold conversations of five minutes with any subscriber in the same town where the station is located, for 10 cents, with any subscriber out of town but in the same division, 15 cents.

TELEGRAPH NEWS.

.... The Gamewell fire alarm system is being put in at Victoria, B. C. Twenty-six boxes will be used.

.... F. V. Moffitt is manager of the Western Union Telegraph Company at Sioux City. The increase in the number of Sioux City messages handled in 1889 is 30,000 over 1888, and three additional operators were put on. The office at Sioux City is the largest in amount of business handled, and in the size of its force, of any in Iowa.

.... The Eastern Telegraph Company at their annual meeting held in Portland, Me., elected the following directors: Frederick Robie, Gorham; C. A. Ginter, N. Y., A. L. Brown, N. Y.; Thomas Roach, Boston; C. C. Barlow, C. D. Livermore, I. W. Plaisted, Portland. The directors then organized with Frederick Robie as president, and C. C. Bedlow, clerk and treasurer.

.... The Chinese Foreign Office has ratified the Chefso agreement, under which the Chinese-European telegraph companies reduce their tariff to $2 a word. Foreign telegraph companies by this agreement acquire means of communication with Hong Kong, Shanghai, Amoy and Foochow and Chinese communication with the rest of China. Each company transmits the messages of the others gratis.

.... A resolution introduced in the House of Representatives on December 18th by Mr. Morrow, directs the Secretary of the Navy to make surveys in the Pacific Ocean and an examination of the bottom of the ocean on certain routes between the United States, the Sandwich Islands, New Zealand and Australia for the purpose of ascertaining the proper location for submarine telegraph cables to connect these or other localities in the Pacific.

.... The Essick printing telegraph instrument is a new invention, which, the owners claim, combines the advantages of the telephone, telegraph and stock ticker. It is practically an electric typewriter, the message being printed in page form in the presence of the transmitter. An exact duplicate is produced on every other machine that may be put in the circuit and a large number may be operated simultaneously. The system is claimed to be more economical and efficient than any in present use.

Prof. Phonograph.

Edison's phonograph has found a new application at the Milwaukee College, where it will be used as an assistant in teaching the French and other foreign languages. The phonograph, of course, never gets tired, and can be made to repeat the same sentence or the same word hundreds of times. In giving a lesson the teacher reads it before the phonograph, at the same time addressing the pupils, and the lesson is reproduced whenever wanted.

ELECTRICAL PATENTS

INDEX OF INVENTIONS FOR WHICH LETTERS PATENTS OF THE UNITED STATES WERE ISSUED ON DECEMBER 24, 1889.

417,742 Electric cam; Henry S Prentiss, New York, N. Y.

417,747 Device for suspending electrical conductors; Sidney H. Short, Cleveland, Ohio.

417,753 Time distributer for electric clocks; Louis H. Spellier, Philadelphia, Pa., assignor to the Spellier Electric Time Company, same place.

417,758 Automatic circuit closer; John Von der Kammer, New York, N. Y., assignor of one-half to James Ward Packard, same place.

417,787 Incandescent lamp socket; James W. Packard, New York, N. Y., assignor to the Westinghouse Electric Company, Pittsburgh, Pa.

417,788 Incandescent lamp socket; James W. Packard, New York, N. Y., assignor to the Westinghouse Electric Company, Pittsburgh, Pa.

417,789 Incandescent electric lamp; James W. Packard, New York, N. Y., assignor to the Westinghouse Electric Company, Pittsburgh, Pa.

417,794 Armature for electric machines; Albert Schmid, Allegheny, and Nikola Tesla, Pittsburgh, assignor to the Westinghouse Electric Company, Pittsburgh, Pa.

417,814 Galvanic battery; Patrick B. Delany, New York, N. Y.

417,842 Device for an electric car-signal; John P. Runkel, Milwaukee, Wis.

417,920 Electric heating apparatus for electric railways; Rudolph M. Hunter, Philadelphia, Pa., assignor to the Electric Car Company, of America, same place.

417,923 Electro-therapeutic apparatus; Frederick J. Kneuper, New York, N. Y., assignor to Emilie Louise Kneuper, and Chas. G. Willing, same place.

417,926 Electric circuit controller; Frederick A. Lane, New Haven, Conn., assignor of one-half to Frank E. Morgan, same place.

417,927 Automatic electric clock-winding device; Frederick A. Lane, New Haven, Conn., assignor of one-half to Frank E. Morgan, same place.

417,928 Electric winding clock; Frederick A. Lane, New Haven, Conn., assignor of one-half to Frank E. Morgan, same place.

417,937 Motor-truck; Edgar Peckham, New York, N. Y.

417,974 Electric railway contract; Francis O. Blackwell, New York, N. Y.

417,992 Underground electric conduit; John Dell, St. Louis, Mo.

418,069 Electrical toy; Henry G. Rogers, Washington, D. C.

418,070 Electrical toy; Henry G. Rogers and Andrew M. Coyle, Washington, D. C.

418,120 Magneto-electric machine; Webster Gillette, New York, N. Y., assignor to C. F. Gillette, same place.

418,125 Electric synchronizing device for clock pendulums; James Hamblet, Brooklyn, N. Y.

418,138 Metallurgical filter; John S. McArthur, Pollokshields, County of Renfrew, Scotland.

418,140 Electrode for secondary batteries; Harry G. Osburn, Chicago, Ills.

Hard on the Pass User.

A bill presented in the House by Mr. Anderson, of Kansas, makes it unlawful for any Senator, Member of Congress, or Judge of any court of the United States to accept a railroad pass or any frank or other authorization to transmit messages over a telegraph line in the United States at less rates than are paid by the general public. Any person offering a railroad pass or a telegraph frank and any company permitting their use is made liable to a fine of $1,000. Before any of the officials named can receive any installment of salary due him he will be required to certify that he has not used any pass or frank during the period covered by the payment due him.

ALTERNATE CURRENT MACHINERY, by GISBERT KAPP. Containing a very full discussion and comparisons of ALTERNATING MACHINES, TRANSFORMERS, MOTORS, METERS and other apparatus for use in central stations, and on premises supplied with current from alternating stations. A book which every worker should have. Will be sent postpaid to any address on receipt of 50 cents.

ELECTRICAL REVIEW,
13 PARK ROW,
P. O. Box 3329. NEW YORK.

SUBSCRIBE NOW FOR THE ELECTRICAL REVIEW.

ELECTRICAL CONTRACT WORK.

DETAILED ESTIMATES MADE AND CONTRACTS TAKEN FOR

EQUIPMENT

OF COMPLETE

STEAM AND ELECTRICAL PLANTS

OF ANY SYSTEM OF

ARC AND INCANDESCENT LIGHTING, CENTRAL STATIONS

AND ELECTRIC STREET RAILWAYS OPERATED OVERHEAD, UNDERGROUND, OR BY STORAGE BATTERIES.

—ADDRESS—

EUGENE T. LYNCH, Jr., Consulting Engineer, 120 Broadway, New York.

ELECTRIC CONDENSER WM. MARSHALL, MANUFACTURER. Standards a Specialty

Rooms 2 and 4, University Building, New York.

Standard Electrical Test Instruments,

AMMETERS AND VOLTMETERS

AYRTON & PERRY NEW SPRING.

Carpentier, Hartmann & Co., Galvanometers, Bridges and Rheostats.

James W. Queen & Co. 924 Chestnut St., PHILA.

EVERYBODY SHOULD HAVE ONE!

EVERYBODY'S HAND-BOOK OF ELECTRICITY.

By EDWARD TREVERT.

With Glossary of Electrical Terms and Tables for Incandescent Wiring.

50 ILLUSTRATIONS. 120 PAGES.

Post-paid, Paper Covers, 25c. Cloth, $1.00

BUBIES' PUBLISHING CO., *LYNN, MASS.*

ELECTRICAL MEASUREMENT

Instruments and Batteries of the Very Highest Grade.

Precision and Constancy, Quality and Finish the Best in the World.

Catalogue of Standard Test Instruments furnished upon application.

THE E. S. GREELEY & CO.,

5 AND 7 DEY ST., NEW YORK.

PEARCE & JONES

77 and 79 JOHN ST.,

NEW YORK CITY,

Manufacturers of and Dealers in all kinds of

ELECTRICAL, Telegraph & Electric Light SUPPLIES.

WOOD BOX BELLS.

HAZAZER & STANLEY,

Electrical House Furnishings,

32 & 34 FRANKFORT STREET, NEW YORK.

EUGENE F. PHILLIPS, PRESIDENT. W. H. SAWYER, SEC. & ELECTRICIAN.

AMERICAN ELECTRICAL WORKS,

Manufacturers of Patent Finished

ELECTRIC LIGHT WIRE,

MAGNET WIRE, OFFICE & ANNUNCIATOR WIRE, RUBBER COVERED WIRE, LEAD ENCASED WIRE, TELEPHONE & INCANDESCENT CORDS.

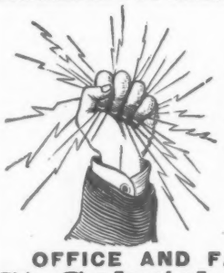
FARADAY CABLES.

Office and Factory, 67 STEWART STREET., PROVIDENCE, R. I.

New York Office, 18 Cortlandt St., P. C. Ackerman, Agt.

EUGENE F. PHILLIPS, PRESIDENT. JOHN CARROLL, SEC'Y-TREAS.

EUGENE F. PHILLIPS ELECTRICAL WORKS, LTD.



Manufacturers of

ELECTRIC LIGHT WIRE,

MAGNET WIRE, OFFICE & ANNUNCIATOR WIRE, RUBBER COVERED WIRE, LEAD ENCASED WIRE, TELEPHONE & INCANDESCENT CORDS.

FARADAY CABLES.

OFFICE AND FACTORY, St. Gabriel Locks, MONTREAL, CANADA.

Hydraulic Presses.

ALL VARIETIES.

Pumps, Valves, Gauges & Fittings,

WATSON & STILLMAN,

210 EAST 43d ST., NEW YORK CITY.

Special Attention to Electrical Work.

W. R. OSTRANDER & CO.

21, 23 & 25 ANN ST., NEW YORK,

Manufacturers of

SPEAKING TUBES, WHISTLES, ANNUNCIATORS, Electric & Mechanical Bells.

FACTORY, De Kalb Avenue, BROOKLYN.

Send for Illustrated Catalogue.

BALL AUTOMATIC CUT OFF ENGINE

MADE ONLY BY THE BALL ENGINE CO ERIE PA.

Eastern Agents, C. R. Vincent & Co., Room 16, 15 Cortlandt St., New York.

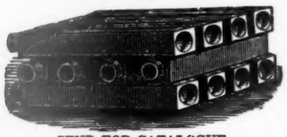
Sperry Electric Company,

Factory, 194 to 198 So. Clinton St., Chicago, Ill.

MANUFACTURERS OF THE

Improved Sperry High and Low Tension Systems of Arc Lighting,

Claiming the Highest Efficiency, Reliability and Durability. Perfect Regulation.



SEND FOR CATALOGUE.

THE WYCKOFF PIPE CO.,

MANUFACTURERS OF

WOODEN PIPES FOR

UNDERGROUND ELECTRICAL WIRES.

We have large works for creosoting Lumber, R. R. Ties, Telegraph Poles, &c., &c.

WILLIAMSPORT, PENN.

GRIMSHAW WHITE CORE INSULATED WIRE

Grimshaw Patented White Core WIRES and CABLES.

FIRE, ACID, AND WATERPROOF. GRIMSHAW TAPE.

NEW YORK INSULATED WIRE Co.,

R. E. GALLAHER, Secretary. Sole Manufacturers,

J. W. GODFREY, Gen'l Manager.

W. B. DOWSE, Treasurer. 649 & 651 BROADWAY, N Y.

SILKS. Full assortment of different sizes and qualities on **BRAIDER SPOOLS,** ready for the machines, in Red, Yellow and Green. Other colors to order. **Send for Sample and Prices.**

WM. MACFARLANE & CO., 55 Mercer Street, New York.

Telephone No. 971 Spring. Mill, Bergen Point, N. J.

Fuse Wire! Fuse Wire!

Accurately Determined. Carefully Made by a new Process. For Sale by

W. H. GORDON & CO.,

ELECTRIC LIGHT AND POWER SPECIALTIES,

Send for Catalogue. 115 BROADWAY, NEW YORK.

CLARK DYNAMO.

MANUFACTURED BY THE

CLARK ELECTRIC COMPANY,

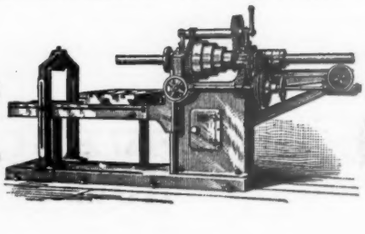
192 BROADWAY, NEW YORK.

ARC LIGHTING APPARATUS A SPECIALTY.

HORIZONTAL DRILLING AND BORING MACHINES.

BEST AND CHEAPEST

Send for Prices and Circulars.



THE NEWARK MACHINE Tool Works,

Newark, N. J.

PARIS,

HIGHEST

AWARD.

1889.

THE ONLY

Gold Medal

GIVEN FOR ELECTRIC BATTERIES

TRADE **GONDA** MARK.

THE LECLANCHÉ BATTERY COMPANY

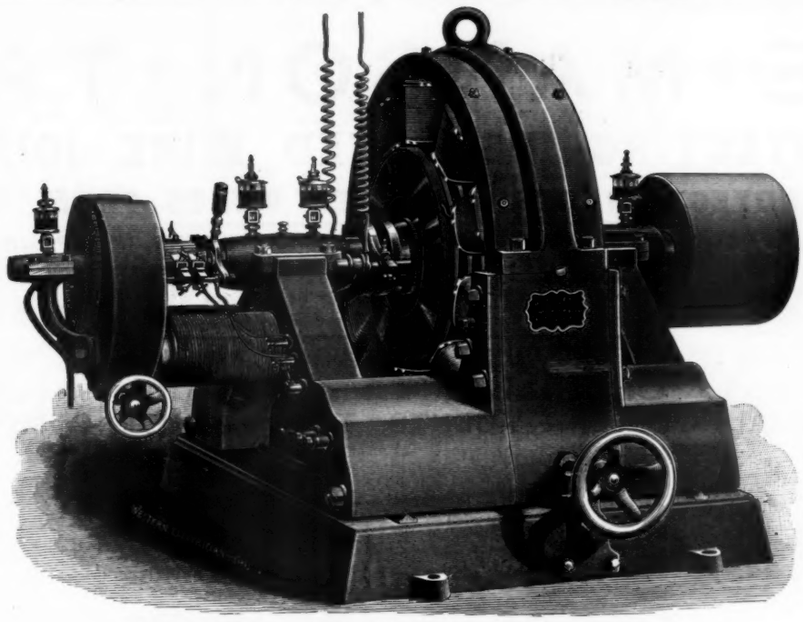
149 WEST 18th STREET, NEW YORK.

NATIONAL ELECTRIC MANUFACTURING COMPANY.

THE WALTER K. FREEMAN

Transformer System of Incandescence Electric Lighting.

We Guarantee 12 Sixteen C. P. Lamps for each Mechanical H. P. applied to dynamo.



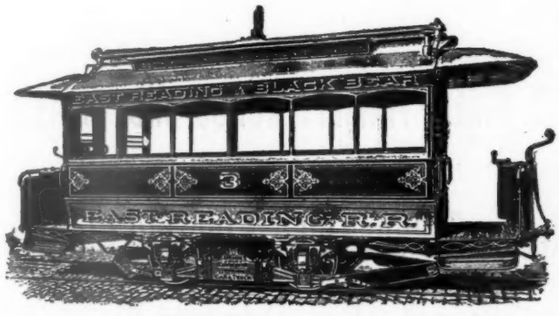
We guarantee our Transformers and Dynamos for two years, and sell our apparatus upon its Satisfactory Performance.

FACTORY, EAU CLAIRE, WIS., U. S. A.

The most perfect system. Agents wanted for New York, Philadelphia, New England and Cincinnati. Correspondence solicited.

BAKER BALCH, General Agent, SEATTLE, WASHINGTON.

THOS. WOLF, Southwestern Agent, UNION DEPOT HOTEL, KANSAS CITY, MO.



JOHN STEPHENSON COMPANY

LIMITED,

NEW YORK.

Street Cars

FOR

Electric Motors.

THE KNAPP ELECTRICAL WORKS,

MANUFACTURERS OF

ELECTRICAL APPARATUS AND SUPPLIES,

ANNUNCIATORS, BURGLAR ALARMS, BELLS, BATTERIES, &c.

Electric Light, Telegraph, Telephone and Fire Alarm Supplies.

AGENTS FOR

NEW YORK INSULATED WIRE CO., Grimshaw White Core and Braided Wires, Tapes, &c.

J. H. BUNNELL & CO., Telegraph Instruments, Line Equipments, Etc.

54 & 56 FRANKLIN STREET, CHICAGO, ILL.

WRITE For the Electrical Review's *New Catalogue* of all Electrical and Scientific Books.
18 PARK ROW, NEW YORK.

BOOKS ON ELECTRICAL SUBJECTS
Will be mailed to any address, postage prepaid, on receipt of price. Address,
ELECTRICAL REVIEW PUB. COMPANY,
18 Park Row, New York P. O. Box. 3,329.

THE MANSON TAPE

FOR

PROTECTING INSULATED WIRE JOINTS,

AND FOR THE

BETTER PROTECTION OF INSULATED WIRES FROM ABRASION.

A FIRST-CLASS ARTICLE SECOND TO NONE. PUT UP IN ¾-INCH WIDTHS, IN ½-POUND PACKAGES. "FULL WEIGHT." ANY SPECIAL WIDTH FURNISHED TO ORDER.

We would respectfully call the attention of consumers and the trade generally to the Tape we have upon the market under the above name. This tape is made of heavy cloth, first saturated with a preparation of itself, a first-class insulator, and which adds greatly to its lasting qualities. A compound is then applied, of a nature that allows one layer to adhere closely to another in such a manner that it will not unwrap, even when exposed to the weather.

WE CLAIM THAT IT IS THE BEST CLOTH TAPE IN THE MARKET. THAT IT WILL NOT OXIDIZE THE SILVER. THAT IT HAS NO SUPERIOR, AND THE PRICE AS LOW AS MANY INFERIOR TAPES NOW BEING SOLD IN THE MARKET. TRY IT.

Central Electric Company, 42 La Salle Street, Chicago.

GENERAL WESTERN AGENTS, THE OKONITE COMPANY.

A NEW BOOK!

WILL BE ISSUED AS SOON AS THE REVISIONARY WORK IS COMPLETED.

Electric Law,

EDITED BY FRED H WHIPPLE.

Being a COMPILATION of all LAWS upon the STATUTE BOOKS of the different States, relating to ELECTRICITY; OPINIONS of the HIGHEST AUTHORITIES where these Laws have been SUBJECTS OF LITIGATION;

PROVISIONS of all MUNICIPAL Electric ORDINANCES and TERMS of all Electric FRANCHISES, whether for LIGHT or POWER.

With ANNOTATIONS, COMPARISONS, EFFECTS, Etc.

A BOOK, THE IMPORTANCE OF WHICH TO THE ELECTRIC WORLD CANNOT BE ESTIMATED.

SEND IN YOUR ORDER. Price, handsomely printed and bound, TEN DOLLARS.

"The Electric Railway" } Paper, $1.00
"Municipal Lighting" } Leather, 2.00

WHIPPLE'S NATIONAL ELECTRICAL DIRECTORY,
IN CLOTH, $10.00.

WHIPPLE'S ELECTRIC REPORTS,

PUBLISHED MONTHLY. *$3.00 PER YEAR.*

ADDRESS

The FRED H. WHIPPLE CO., DETROIT, MICH.

Or any Electrical Journal and the Leading Book Stores.

New York Office: - - - 18 Cortlandt Street.

EDISON MACHINE WORKS,

Schenectady, N. Y.

MANUFACTURERS OF

INSULATED WIRES, FLEXIBLE CORDS AND CABLES,

—FOR—

Telephone, Telegraph AND Electric Light.

JAMES F. KELLY.

GENERAL SALES AGENT,

19 Dey Street, New York.

DO NOT CALL

At No. 429 Walnut Street., for I have removed to Room 714, Girard Building, cor. Broad and Chestnut Streets, Phila., where I am prepared to furnish specifications and drawings of any class of electrical work.

C M. BLANCHARD.

Philadelphia, Dec. 17, 1889.

ROYCE & MAREAN,

DEALERS IN

ELECTRICAL APPARATUS

Telegraph and Telephone Supplies,

No. 1408 Penna. Avenue,

Opp. Willard's Hotel. **WASHINGTON. D. C.**

Mouldings, Cleats, Rosettes.

ADDRESS

WILLIAM B. McLEAN,

Nos. 1038 to 1050 33d ST., PITTSBURGH, PA.

COMPOUND. CONDENSING OR NON-CONDENSING.
16 Sizes, 5 to 500 H. P. Not yet equaled by any form of Engine for HIGH FUEL DUTY AND SIMPLICITY.

STANDARD. 13 Sizes in Stock. 5 to 250 H. P.
3,000 in use in all parts of the Civilized World.

JUNIOR. 6 Sizes in Stock, 5 to 50 H. P.
AN AUTOMATIC ENGINE CHEAPER THAN A SLIDE VALVE.
Well Built. Economical. Reliable. Over 300 sold the first year.

All the above built strictly to Gauge with Interchangeable Parts. Repairs Carried in Stock. Send for Illustrated Catalogues.

WESTINGHOUSE ENGINES

The Westinghouse Machine Co.
PITTSBURGH, PA. U.S.A.

SELLING DEPARTMENT IN THE UNITED STATES.

NEW YORK,	17 Cortlandt Street,	Westinghouse, Church, Kerr & Co.
BOSTON,	Hathaway Building,	
PITTSBURGH,	Westinghouse Building,	
CHICAGO,	156, 158 Lake Street,	
PHILADELPHIA,	606 Chestnut St.,	M. R. Muckle, Jr. & Co.
ST. LOUIS,	302, 304 Washington Ave.	Fairbanks & Co.
KANSAS CITY,	312 Union Avenue.	
DENVER,	1330 Seventeenth Street,	
OMAHA,	1619 Capitol Avenue,	F. C. Ayer.
PINE BLUFFS, Ark.		Geo. M. Dilley & Sons.
SALT LAKE CITY,	220 S. Main St.	Utah & Montana Machinery Co.
BUTTE, MONT.	E. Granite St.	
SAN FRANCISCO,	21 and 23 Fremont St.,	Parke & Lacy Co.
PORTLAND, OR.	33, 35 N. Front St.,	Parke & Lacy Mch. Co.
CHARLOTTE, N. C.	36 College St.,	The D. A. Tompkins Co.
ATLANTA, GA.	45 S. Prior St.	Keating Imp. & Mch. Co.
DALLAS, TEX.		
CHATTANOOGA, TENN.		C. E. James & Co.

HEADQUARTERS
— IN —
NEW YORK CITY
— FOR —
STANDARD MILLING MACHINES.

UNIVERSAL, LIGHT, OR PLAIN FOR HEAVY WORK.

ALL SIZES READY FOR QUICK DELIVERY.

MACHINES SHOWN IN OPERATION

BY THE MANUFACTURERS,

THE GARVIN MACHINE CO.,
LAIGHT & CANAL STREETS, NEW YORK CITY.
SEND FOR ILLUSTRATED CATALOGUE.

THE RICE AUTOMATIC
GUARANTEED ECONOMY
REGULATION · DURABILITY ·
SIMPLICITY · SELF-CONTAINED ·
8 TO 300 H.P. PAIR & TANDEM COMPOUNDS.
THE JOHN T. NOYE MFG CO. BUFFALO, N.Y.
CHICAGO OFFICE, 64 SOUTH CLINTON STREET.

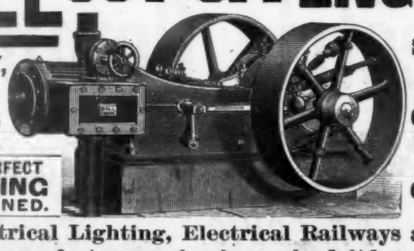
JARVIS ENGINEERING COMPANY,
CONTRACTING ENGINEERS for ERECTING COMPLETE STEAM PLANTS
For Electric Lighting and Power Stations.

—: AGENTS FOR :—
ARMINGTON & SIMS ENGINES,
JARVIS BOILER SETTING,
to burn Anthracite Coal and Coke Screenings,
NATIONAL FEED WATER HEATER,
NATIONAL ROCKING and SHEFFIELD GRATE BARS.

61 Oliver Street, Boston.

SEND FOR NEW CATALOGUE.

BALL AUTOMATIC CUT-OFF ENGINE



RELIABILITY,
ECONOMY,
SIMPLICITY,
DURABILITY.
THE MOST PERFECT GOVERNING EVER OBTAINED.

STANDARD
DOUBLE COMPOUND
TANDEM COMPOUND

For Electrical Lighting, Electrical Railways and purposes where perfect governing is required, it has no equal.

BALL ENGINE CO., ERIE, PA.

FRICTION CLUTCH PULLEYS
AND CUT-OFF COUPLINGS.

CHARACTERISTICS:
Vice-Like Grip of Clutches Optionally Gradual or Sudden. Large Friction Surfaces Prevent Undue Wear. Disengagement of Clutches is Positive. Pulley Shaft is Automatically Oiled. They have a Good Record. Grip of Clutches Self-Maintaining. Experts are invited to examine Peculiarities.

ECLIPSE WIND ENGINE CO.,
Send for 1889 Catalogue. Beloit, Wis.

R. T. WHITE,
12 Pearl St. (Room 6), BOSTON, MASS.

NO BOLTS THROUGH THE RAILS.

DAISY CHAIR.

IMPROVED
PATENTED MATERIAL
FOR STREET RAILWAY
ROADBEDS.

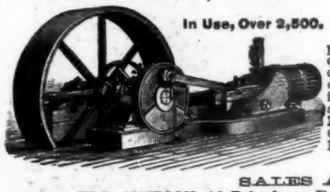
BEST MATERIAL, LOWEST PRICES, CORRESPONDENCE SOLICITED.

THOMAS ASHBURNER, Western Agent, Kansas City, Mo.

Rolled any weight desired. Patent allowed.
Sample Chair and Section of Rail Sent, Express Prepaid, to Prospective Purchasers.

New Tangye Buckeye Automatic Cut-off Engines.

In Use, Over 2,500.



25 to 1,000 H. P.

These engines are the combined result of long experience with automatic cut-off regulation, and most careful revision of all details. They are designed and constructed for heavy and continuous duty at medium or high rotative speeds. Highest attainable Economy in Steam Consumption and Superior regulation guaranteed. Self-contained Automatic Cut-off Engines 12 to 200 H. P. for driving Dynamo Machines a Specialty. Illustrated Circulars, with various data as to practical Steam Engine Construction and performance, free by mail.

Address BUCKEYE ENGINE CO., Salem, Ohio.

SALES AGENTS:
W. L. SIMPSON, 10 Telephone Building, 18 Cortlandt Street, N. Y.
H. W. ROBINSON, 154 Washington St., Chicago, Ill. ROBINSON & CARY, St. Paul, Minn.

WILLIAMS & POTTER,
15 CORTLANDT ST., NEW YORK.
Engineers & Contractors,
GENERAL AGENTS,
STRAIGHT LINE ENGINES

Bernstein Electric Co.

INCANDESCENT LAMPS
— FOR —
ARC LIGHT CIRCUITS,
SIMPLE. RELIABLE. DURABLE.

The only safe socket for series lamps and the only socket having insulating material for the outside parts.

Send for Illustrated Catalogue.

620 Atlantic Ave., BOSTON.
CHICAGO OFFICE, 80 ADAMS ST., GEORGE CUTTER, Agent.

CHARLES R. VINCENT & CO.,
15 CORTLANDT STREET, NEW YORK,
Ball High Speed Automatic Cut-off Engines
MANNING VERTICAL TUBULAR BOILERS,
Complete Steam Plants Furnished and Erected.

The Incandescent Lighting System

OF THE

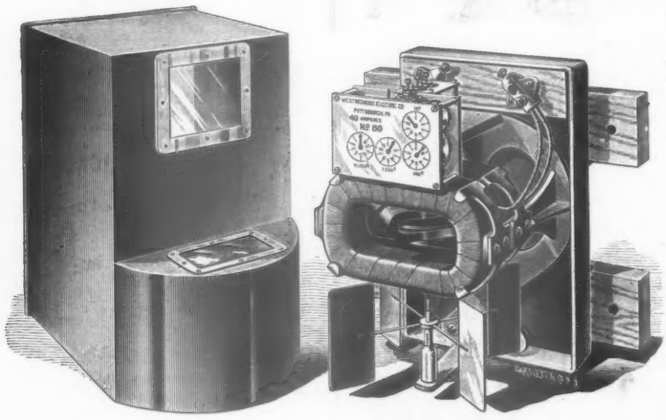
Westinghouse Electric Company,

BY ALTERNATE CURRENTS,

Assures Equity, Safety, Economy

A PERFECT MEASURING APPARATUS:

The Shallenberger Alternate Current Meter.



OVER 11,000 OF THESE METERS IN ACTUAL USE.

COMPLETE CENTRAL STATION MACHINERY.

Dynamos for 500 to 5,000 Sixteen Candle-power Lamps.

The Westinghouse Electric Company

PITTSBURGH, PENNA., U. S. A.

BOSTON, NEW YORK, CHICAGO, ST. LOUIS, CINCINNATI,
SAN FRANCISCO, PORTLAND, CHARLOTTE, DALLAS.

THOMSON-HOUSTON APPARATUS

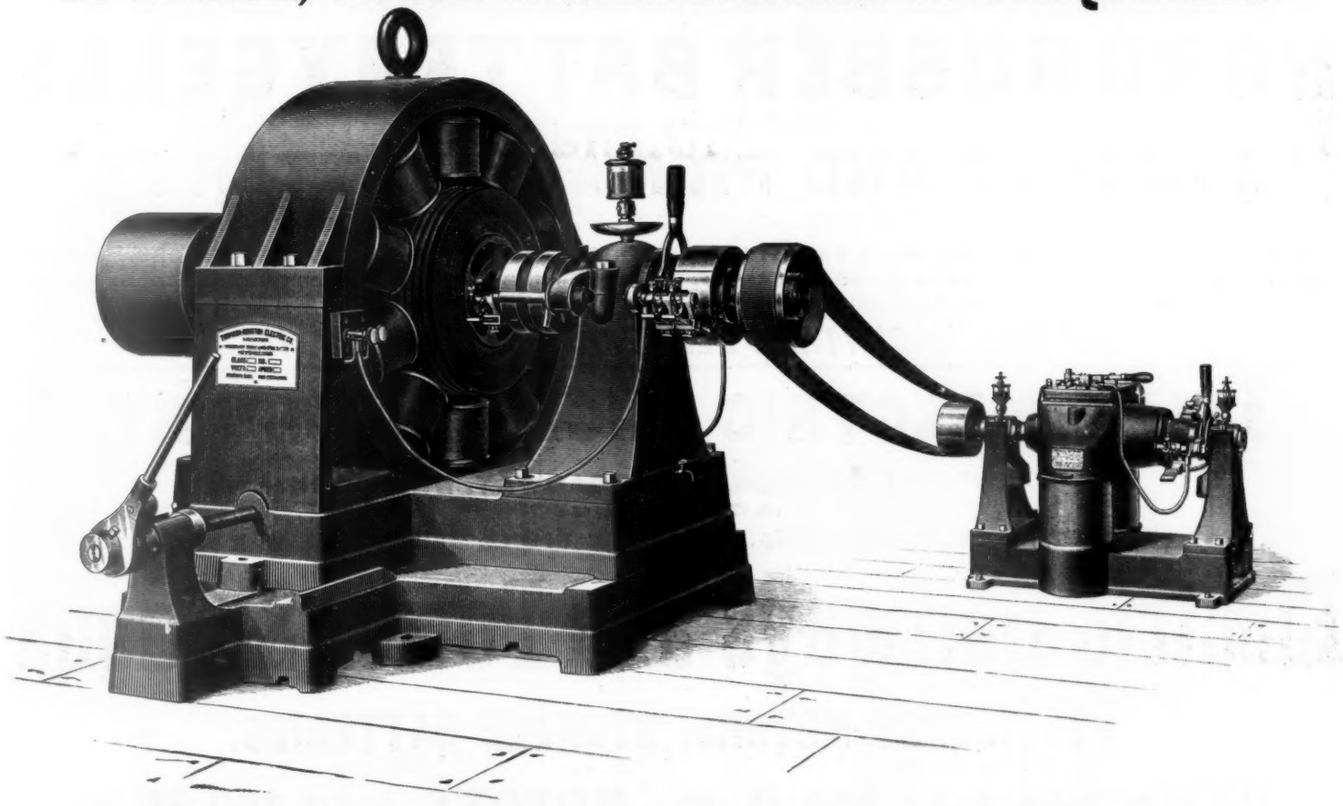
FOR

INCANDESCENT LIGHTING

BY

ALTERNATING CURRENTS

IN DESIGN, FINISH AND OPERATION IS UNEQUALLED.



Simple in Construction. Perfect Ventilation of the Armature. Spherical Bearings.

Interchangeable Parts. Minimum of Repairs. Automatic Self-Regulation. Economical Operation.

DYNAMOS. LAMPS. TRANSFORMERS. CURRENT INDICATORS.
POTENTIAL INDICATORS. LIGHTNING ARRESTERS. METERS.

COMPLETE STATION EQUIPMENTS.

THE THOMSON-HOUSTON ELECTRIC COMPANY.

620 Atlantic Avenue, Boston, Mass.
Wall and Loyd Streets, Atlanta, Ga.
1110 Noble Street, Philadelphia, Pa.
215 West Fourth Street, Cincinnati, O.
148 Michigan Avenue, Chicago, Ill.
115 Broadway, New York City.
234 Montgomery Street, San Francisco, Cal.
403 & 405 Sibley Street, St. Paul, Minn.
503 Delaware Street, Kansas City, Mo.

W. D. SARGENT, President.
E. H. CUTLER, Treasurer and Manager.

JNO. A. BARRETT, Vice-President and Consulting Electrician.
FRANK A. PERRET, Electrician.

The Elektron Manufacturing Company

79 and 81 WASHINGTON STREET, BROOKLYN, N. Y.,

MANUFACTURERS OF

PERRET ELECTRIC MOTORS AND DYNAMOS.

AUTOMATICALLY REGULATED.

Unexcelled in Simplicity and Durabiltiy.

THE ONLY MACHINES HAVING

LAMINATED FIELD MAGNETS

OF SOFTEST CHARCOAL IRON,

BY MEANS OF WHICH

HIGHER EFFICIENCY,

CLOSER REGULATION

AND SLOWER SPEED

Are Obtained than is Possible Otherwise.

CAREFUL INVESTIGATION INVITED.

THE BUTLER HARD RUBBER CO.,

No. 33 MERCER STREET, NEW YORK,

Manufacturers of Hard Rubber Goods of Every Description Including the Celebrated

HARD RUBBER BATTERY CELLS

MANUFACTURED UNDER KIEL'S PATENTS FOR

STORAGE AND PRIMARY BATTERIES.

CHEAPEST AND BEST CELLS IN THE MARKET.

Also SHEET, ROD AND TUBING (Kiel's Patent), for ELECTRICAL PURPOSES at REDUCED PRICES. Standard quality Sheet, Rod, Tubing, Insulator Hooks, Key Knobs, Switch Handles, Telephone Receivers and Battery Syringes constantly on hand. Hard Rubber Specialties of all kinds made to order. Send for Prices and Estimates.

For Sale by CENTRAL ELECTRIC CO., CHICAGO, ILL.

DAFT ELECTRIC LIGHT COMPANY,

EXECUTIVE OFFICES, 115 BROADWAY, NEW YORK.

AGENCIES:

13 South 4th St., Philadelphia. 119 La Salle Street, Chicago.

Electric Railways and Power Stations,

STATIONARY MOTORS, STORAGE BATTERIES.

DYNAMOS, 1 to 250 H. P. MOTORS, ½ to 100 H. P.

WORKS, JERSEY CITY, N. J.

"C. & C." Electric Motor Company,

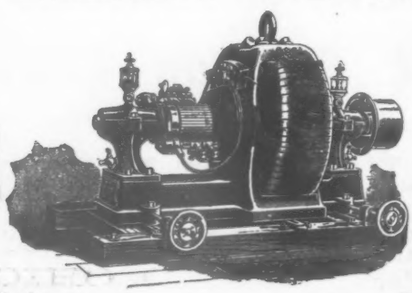
402 & 404 GREENWICH STREET, NEW YORK.

ALL STANDARD SIZES

—: OF :—

ELECTRIC MOTORS

From 1/8 H. P. to 40 H. P.



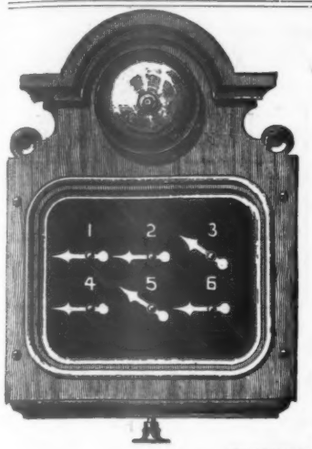
OVER 6,000 NOW IN USE

IN THE UNITED STATES,

Running Sewing Machines, Elevators, Printing Presses, Ventilating Fans, Blowers, Coffee Mills, Polishing and Grinding Tools, etc.

NEW ENGLAND OFFICE: 32 Oliver Street, Boston.
PHILADELPHIA OFFICE: 301 Arch Street.

CHICAGO OFFICE: Phenix Building.
CINCINNATI OFFICE: 99 West Fourth Street



We have added to our list of ELECTRIC BELL SUPPLIES a new Needle Annunciator which we call our "No. 2." ANNUNCIATOR. It is attractive in appearance and well made, and we believe is what has been wanted, namely:

An Annunciator which is Cheap in Price but not Cheap in Appearance.

We propose to furnish Electric Bell Supplies, which can be relied upon, at low prices, and will take pleasure in making quotations.

WESTERN ELECTRIC CO.,

CHICAGO. NEW YORK.

AMES, CRERAR & CO., Northwestern Agents, ST. PAUL, MINN.

BAIN, 76 Market Street, CHICAGO, ILL.,

General Electrical Work, in all branches of Electrical Engineering. Consultation, etc. Correspondence confidential. TRY ME.

THE LEHIGH VALLEY

CREOSOTING CO.

WORKS, PERTH AMBOY, N. J.

Office, Foot of Washington Street, JERSEY CITY, N. J.

Creosoted Lumber, Underground Conduits, Telegraph Poles, Piling and Ties Furnished.

Ball Electric Light Co.,

18 CORTLANDT ST. NEW YORK

MANUFACTURERS

The Celebrated **BALL DYNAMOS and LAMPS**

— FOR —

ARC AND INCANDESCENT LIGHTING.

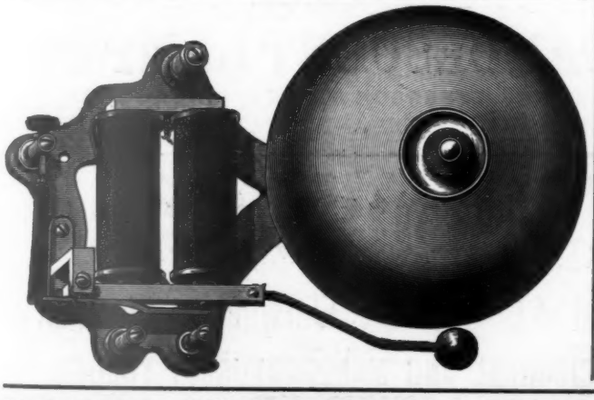
This System is **mechanically** and **electrically** perfect and produces a steady, white and noiseless light with the minimum of expense, both as to the power required and the cost of repairs.

For descriptive Circulars or Testimonials, address

FACTORY: 9th Ave. & 27th St., New York City.

BALL ELECTRIC LIGHT CO., 18 Cortlandt St., N. Y. City.

Manufacturers



H. E. & C. BAXTER, 18 Fulton Street, Brooklyn, E. D.

BOOKS ON ELECTRICAL SUBJECTS

Will be mailed to any address, postage prepaid, on receipt of price. Address, ELECTRICAL REVIEW PUB. COMPANY, 13 Park Row, New York. P. O. Box, 3,329.

THE STREET RAILWAY JOURNAL

Vol. V. 113 Liberty St., New York. Monthly, $2.00 Per Year.

THE STREET RAILWAY JOURNAL, 113 Liberty Street, NEW YORK.

CONTENTS.

Each issue contains 120 pages or more, including 30 pages of reading matter and illustrations

A Directory of Street Railways in the United States and Canada.

A Directory of Manufacturers of street railway appliances and materials.

Is the Best Advertising Medium through which to reach Street Railways.

Style "C" Hotel Annunciator

WITH RETURN CALL.

FOR PRICES, ETC., SEE OUR CATALOGUE.

FRANKLIN S. CARTER. CHAS. M. WILKINS. E. WARD WILKINS

TRADING AS

PARTRICK & CARTER,

Manufacturers of and Dealers in

Electrical Supplies

SOLE PROPRIETORS OF THE PATENT NEEDLE ANNUNCIATORS,

114 SO. SECOND ST., PHILADELPHIA, PA.

— ESTABLISHED 1867. —

THE NATIONAL CARBON CO.

CLEVELAND, OHIO.

MANUFACTURERS OF

ELECTRIC LIGHT CARBONS AND BATTERY MATERIAL.

OKONITE
TRADE MARK.
WIRES, CABLES, TAPE AND CORD.

LOOK TO US
FOR ELECTRICAL SUPPLIES
OF EVERY DESCRIPTION.
We Guarantee Prompt Shipments, Low Prices, and the Best of Goods.

INCANDESCENT
LAMPS
—AND—
ALL KINDS OF FITTINGS.

Southern Electrical Supply Company
310 NORTH THIRD STREET,
ST. LOUIS, MO.
WRITE FOR CATALOGUE.

P. MINTURN SMITH - President
WILLIAM D. PERRY - Vice Prest.
G. G. FRELINGHUYSEN - Secretary

CHARLES TREMAINE - Treasurer
JAMES W. EASTON — Electrician

THE EASTON ELECTRIC Co.
ELECTRICAL APPARATUS FOR ARC AND INCANDESCENT LIGHTING
Office 45 BROADWAY
New York.

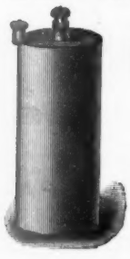
H. E. THURBER, PREST. HENRY E. HAWLEY, VICE-PREST. JAMES A. TAYLOR, SECY. AND TREAS.

THE COMPLETE ELECTRIC CONSTRUCTION CO.,
14 Cortlandt Street, New York.
CONTRACTORS FOR ELECTRICAL CONSTRUCTION OF ALL KINDS.
SPECIAL ATTENTION PAID TO LAYING UNDERGROUND, DEEP SEA AND AERIAL CABLES.
STORAGE BATTERY POWER FURNISHED AND MAINTAINED.
ELECTRIC LIGHT INSTALLATIONS A SPECIALTY.
JOHN A. SEELY, Gen'l Manager.

SUNLIGHT CARBONS

THE
PARKER-RUSSELL MINING & MFG. CO.
MERMOD-JACCARD BUILDING,
Cor. Broadway and Locust St. Rooms 307 and 308.
ST. LOUIS.
UNIFORM IN QUALITY, LONG LIFE AND GOOD LIGHT.

SERIES LAMPS. LONG LIFE. LOW PRICE BATTERY LAMPS. HIGH EFFICIENCY.
PHŒNIX
INCANDESCENT LAMP CO.
13 to 17 N. JEFFERSON STREET, CHICAGO, ILL.
LAMPS TO FIT ANY SYSTEM, ANY VOLTAGE OR CANDLE POWER.

DR. GASSNER'S DRY BATTERY.

Acknowledged by experts to be the Best Open Circuit Battery in the Market, the most durable and convenient for
Electric Bells, Gas Lighting, Telephones, Signals, Electric Clocks, Stationary Batteries for Physicians and Many Other Uses.
No Liquid. No Glass.
HIGHEST TESTIMONALS. WRITE FOR CIRCULAR.
For Sale by The Western Electric Co. CHICAGO, ILL.
And California Electrical Works, SAN FRANCISCO, CAL.
A. SCHOVERLING,
SOLE AGENT AND MANUFACTURER,
111 Chambers Street, New York.

Industries.
— A —
Journal of Engineering, Electricity & Chemistry
— FOR THE —
MECHANICAL AND MANUFACTURING TRADES.
PUBLISHED EVERY FRIDAY.

ANNUAL SUBSCRIPTIONS.	Thick Paper.	Thin Paper.
GREAT BRITAIN, Post Free	$6 00	$6 00
THE UNITED STATES, CANADA and COUNTRIES INCLUDED IN THE POSTAL UNION, Post Free	9 00	8 00
INDIA, CEYLON, STRAITS SETTLEMENTS, CHINA, JAPAN, &c., Post Free	10 75	9 00

SUBSCRIPTIONS PAYABLE IN ADVANCE TO
CEO. CAWLEY, 358 STRAND, LONDON, W. C.
Manchester, 70 Market St.; Glasgow, 93 Hope St.; Yokohama (Japan), 32 Main St.
American Subscriptions to "Industries" are received by the Publisher of the ELECTRICAL REVIEW, 13 Park Row, New York.

PRESSELLES.

The Neatest and Cheapest thing of the kind on the market. Write for prices.

LIBERAL DISCOUNT TO THE TRADE

Send for Catalogue of

MAGNETO BELLS,
DISTRICT CALL BOXES,
BATTERY BELLS,
WOOD CLEATS, BATTERIES,
PUSH BUTTONS, ETC.

VIADUCT MANUFACTURING CO.,

CHARLES AND GERMAN STREETS, BALTIMORE, MD.

THE American Bell Telephone Company,

95 MILK ST., BOSTON, MASS.

This Company owns the Letters Patent granted to Alexander Graham Bell, March 7th, 1876, No. 174,465, and January 30, 1877, No. 186,787.

The Transmission of Speech by all known forms of ELECTRIC SPEAKING TELEPHONES infringes the right secured to this Company by the above patents, and renders each individual user of telephones, not furnished by it or its licensees, responsible for such unlawful use, and all the consequences thereof and liable to suit therefor.

GIVES MORE POWER USING LESS WATER THAN ANY OTHER WHEEL.

THE OLD RELIABLE
—LEFFEL—
WATER WHEEL
SEND FOR CATALOGUE

JAMES LEFFEL & CO.
SPRINGFIELD, O., OR 110 LIBERTY ST., N.Y.

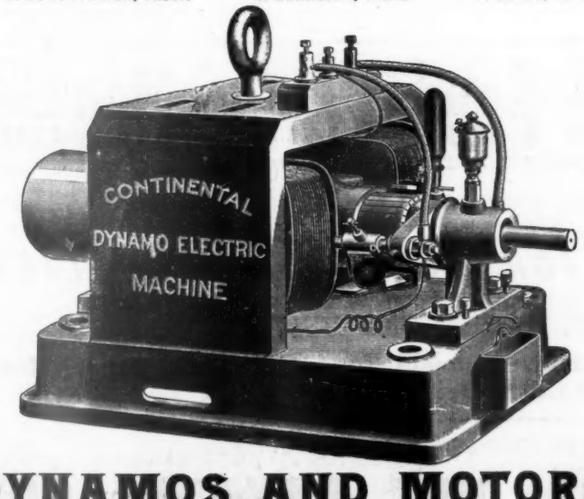
BROWNLEE & CO.
DETROIT, MICH.
DEALERS IN
CEDAR TELEGRAPH POLES
MANUFACTURERS OF
Cross Arms Pins and Brackets.
Cedar Ties for Electric Railways.

CONTINENTAL DYNAMO COMPANY,

NEW YORK.

OFFICE:
63 BROADWAY.
C. SCHUMACHER, PREST.

FACTORY:
162 AND 164 W. 27th ST.
V. SCHALLER, TREAS. P. CLAUS, SUPT.



DYNAMOS AND MOTORS.

ADVANTAGES CLAIMED:

Simplicity and Solidity of Construction. Compactness and Small Size. High Efficiency and No Waste of Power. No Magnetism Outside. Accessibility of the Different Parts. Lower Cost than all other known Dynamos.

The Mitchell Vance Company

(SUCCESSOR TO MITCHELL, VANCE & CO.)

DESIGNERS AND MAKERS OF

ARTISTIC

Electroliers & Combination Fixtures

FOR ANY SYSTEM OF INCANDESCENT ELECTRIC LIGHTING.

The feeling is growing that these goods should be specially adapted to the light medium; to meet this want New Designs of Artistic merit and unexcelled finish have been originated which commend themselves to intending purchasers, being shown in Parlors illuminated by Electric light.

Architects and Decorators Designs and suggestions carried out with fidelity to the given motive.

MANUFACTORY,
24th & 25th Sts. & 10th Ave.

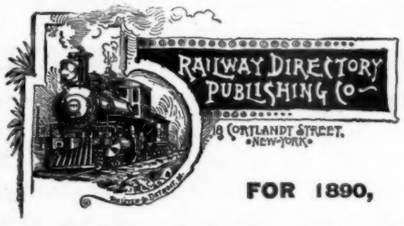
SALESROOMS,
No. 836 & 838 BROADWAY,
NEW YORK.

L. F. JORDAN, Patentee and General Manager. W. S. HILL, Consulting Engineer

JORDAN'S

System of Electric Lighting for Street Railway Trains has been in perfect operation on the West End Street Railway in Boston for a Month.

L. F. JORDAN & CO., 133 Oliver St., Boston, Mass.



Just Issued,

FOR 1890,

THE RAILROAD, TELEGRAPH & STEAMSHIP BUILDERS' DIRECTORY.

A United States Business Directory containing the names of manufacturers and dealers, covering all articles, devices and materials used in the construction and operation of **Railroad, Telegraph, Steamship, Heat and Power, Electric Light Co.s' etc.,** including dealers in **Lumber, Iron and Steel. Locomotive and Car Builders, Railroad, Bridge and other Contractors; Electric Light, Telegraph and Telephone Co.'s; Ship Builders and Materials.**

Including a list of every Railroad in the United States, Canada and Mexico, giving length in miles, Rolling Stock and Officials in charge of ordering and **Purchasing Supplies;** together with valuable tables useful in **Railroad Construction.**

Price, $2.50.

EXTRACT FROM THE REPORT

— OF —

DR. SCHUYLER S. WHEELER,

— ON —

Underground Arc Light Wires in New York.

The line in 125th Street, 2,000 feet in length, is laid in the small ducts of the Johnstone system of conduits. The cable is a ***BISHOP GUTTA PERCHA WHITE CORE,*** and was laid immediately after the order for the work was given. The cable was connected to overhead arc light wires by running it up in a two-inch iron pipe fastened to the outside of an ordinary city electric lamp post. Connections were made with lights in front of stores by carrying the cable from the ducts in iron pipes under the sidewalk and up the front of the stores. This line has been in continuous use for two months, carrying a pressure of 2,500 volts, and it shows an actual rise in insulation with age and use, as will be seen from the following tests:

Jan. 11th, 1,100 Megohms.
Feb. 12th, 1,800 Megohms.
April 12th (including eight arc lamps and branch leads), 2,000 Megohms.

All our White Core India Rubber Insulation is Same Quality as on above cables.

BISHOP GUTTA PERCHA CO.,

420-426 EAST 25TH ST., NEW YORK.

EXCELSIOR ELECTRIC CO.,

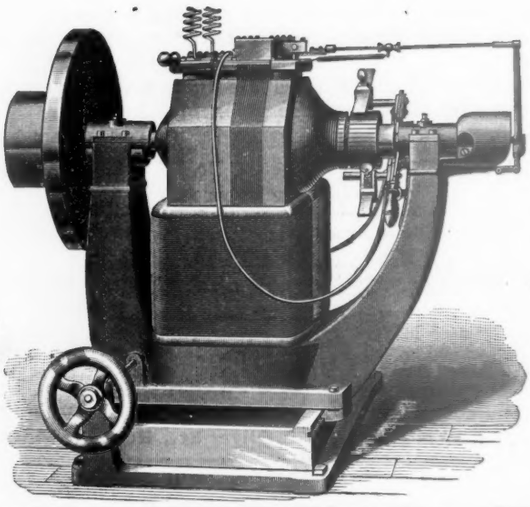
WILLIAM HOCHHAUSEN, ELECTRICIAN.

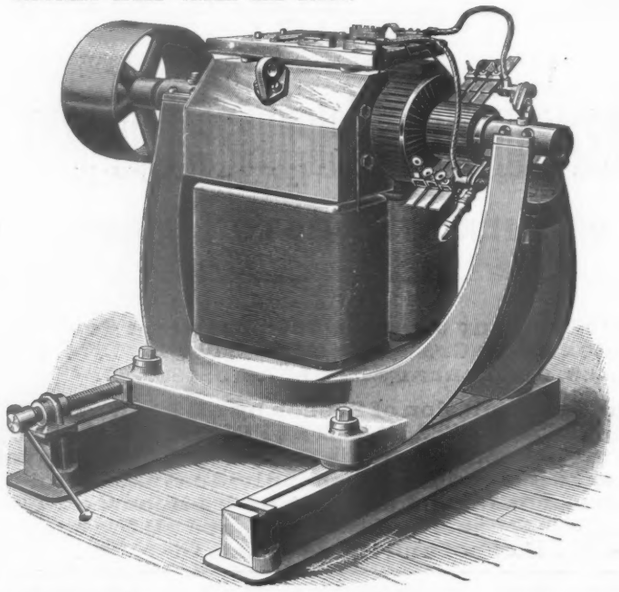
MOTORS

FOR ARC AND INCANDESCENT CIRCUITS.

WOUND FOR ANY CURRENT. PERFECT AUTOMATIC REGULATION

HIGHLY EFFICIENT AND ECONOMICAL. CONSTANT SPEED UNDER ALL LOADS.





OFFICE, 115 BROADWAY, N. Y. WESTERN OFFICE, 11 E. ADAMS ST., CHICAGO.

HOLMES, BOOTH & HAYDENS,

MANUFACTURERS OF

BARE AND INSULATED WIRE,

Underwriters' Copper Electric Light Line Wire, handsomely finished, highest conductivity. Copper Magnet Wire, Flexible Silk, Cotton and Worsted Cords for Incandescent Lighting. Round and Flat Copper Bars for Station Work. Insulated Iron Pressure Wire.

TRADE MARK "K.K."

PATENT "K. K." LINE WIRE

TRADE MARK "K.K."

For Electric Light, Electric Railways, Motors, Telegraph and Telephone Use.

Agents for the WASHINGTON CARBON CO.,

FACTORIES: WATERBURY, CONN.

J. L. BARCLAY, Selling Agent, THE ROOKERY, CHICAGO, ILL.

NEW YORK OFFICE, 25 Park Place, THOS. L. SCOVILL, NEW YORK AGENT.

The National Feed-Water Heater.

Over 300,000 Horse Power in use in the United States.

200 ELECTRIC LIGHT STATIONS SUPPLIED.

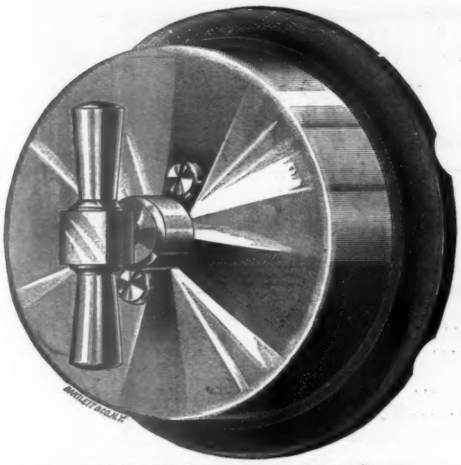
PRICES LOW. SATISFACTION UNIVERSAL.

Seventeen sizes Manufactured, 8 to 2,000 Horse Power Capacity. Heats the Water for the Boilers up to 206° to 212° F.

SEND FOR LIST OF USERS AND EXAMINE FOR YOURSELF.

THE NATIONAL PIPE BENDING CO.,

84 River Street, New Haven, Conn.



DOUBLE POLE BRANCH SWITCH, FOR INCANDESCENT CIRCUITS, WITH COVER.

O. E. MADDEN, President. E. T. GILLILAND, Vice-President.

THE EMPIRE CITY ELECTRIC CO.,

15 DEY STREET, NEW YORK.

MANUFACTURERS OF AND DEALERS IN

Electrical Supplies and Material

OF ALL KINDS FOR

Light, Railway, Power, Telegraph & Telephone Companies.

Housework Supplies,
Fire Alarm Apparatus,
Poles, Brackets, Pins, Insulators,
Switches, Cut-Outs, Mouldings,
Bare and Insulated Wire.

SWITCH, WITH COVER REMOVED, SHOWING DETAILS.

EVERYTHING IN THE ELECTRICAL LINE.

SEND FOR CATALOGUE AND PRICES.

16x24 DOUBLE BRAIDER.

NEW ENGLAND BUTT CO.,

Providence, R. I.,

MANUFACTURERS OF

Braiding Machinery

FOR COVERING

TELEGRAPH, TELEPHONE

AND

ELECTRIC-LIGHT WIRE

ALSO

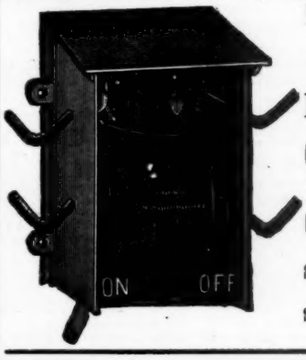
SINGLE AND DOUBLE

WINDERS AND BRAIDERS

Of every Description for Silk, Worsted and Cotton Braid.

FINE CASTINGS A SPECIALTY

THE E. S. GREELEY & CO.,



Nos. 5 & 7 Dey St., New York

Manufacturers and Importers of and Dealers in

Telegraph, Telephone — AND — Electric Light Supplies

AGENTS FOR

Cleveland Arc Light Cut Outs & Gang Switches

Cleats, Rosettes, Moulding, Pins, Cross-Arms, Brackets. Insulating Tapes.

Rubber, Porcelain and Glass Insulators

WIRES OF ALL KINDS.

Silk & Cotton Covered Flexible Conducting Cord of various sizes for Incandescent Lighting.

Spikes, Pole Steps, Lag Screws, Drive Screws, Turn Buckles, Etc.

POND ENGINEERING CO.,

ENGINEERS AND CONTRACTORS.

Complete Steam Plants for Electric Light and Power.

Engines, Boilers, Furnaces, Grates, Heaters, Pumps, Injectors, Pipe Work, Belting, etc., designed with special reference to the HIGHEST EFFICIENCY.

Our Extended Experience Enables us to Guarantee Satisfaction. Send for New Illustrated Pamphlet.

ST. LOUIS, CHICAGO, KANSAS CITY AND OMAHA.

PENNSYLVANIA RAILROAD.

THE GREAT TRUNK LINE OF THE UNITED STATES.

The Standard Railway of America. Double Track. Steel Rails. Stone Ballast and Stone Bridges. Protected Throughout by the Interlocking Switch and Block-Signal System.

THE SCENIC LINE TO THE WEST AND THE ROUTE OF THE CELEBRATED PENNSYLVANIA LIMITED,

The Ideal Train of the Nineteenth Century,

WHICH LEAVES NEW YORK DAILY AT 10 A. M. FOR CINCINNATI AND CHICAGO.

Five Fast Express Trains Daily between New York & Western Points.

Twelve Fast Express Trains between New York, Baltimore, Washington & Southern Points.

FINEST EQUIPMENT, UNEQUALLED SPEED, AND GREATEST COMFORT.

☞ *Through Parlor, Sleeping and Dining Cars on all Express Trains.*

CHARLES E. PUGH, Gen. Man. J. R. WOOD, Gen. Pass. Agent.
SAMUEL CARPENTER, East. Pass. Agent, 849 Broadway, New York.

J. ELLIOTT SHAW & CO.
MFG'RS & DEALERS
ELECTRICAL
53 & 55 NO. SEVENTH ST.
PHILADELPHIA
APPLIANCES

DO YOU READ

THE COSMOPOLITAN,

THAT BRIGHT, SPARKLING YOUNG MONTHLY MAGAZINE?

THE COSMOPOLITAN IS PRONOUNCED BY THE PRESS "THE BEST AND CHEAPEST ILLUSTRATED MAGAZINE" IN THE WORLD.

AN UNUSUAL OPPORTUNITY

ELECTRICAL REVIEW, per Year (regular price)..... $3 00
THE COSMOPOLITAN, " " 2 40

The Price of the two publications..... $5 40
We will furnish BOTH one Year for only..... **$3.20**

This is a Saving of **$2.20** to every Subscriber—an Unprecedented Offer.

THE COSMOPOLITAN is a Splendidly Illustrated Periodical.

TRY IT FOR A YEAR.

It will be a liberal education to every member of the Household. It will make the long winter evenings pass pleasantly; it is a first-class Magazine, giving annually 1,300 pages by the ablest writers and cleverest artists—as readable a Magazine as money can make—a Magazine that makes a specialty of live subjects.

Send $3.20 to the ELECTRICAL REVIEW Office, and secure both THE COSMOPOLITAN and the ELECTRICAL REVIEW at a cost only 20 cents higher than our regular subscription price. All subscriptions should be sent in before January 1, 1890.

P. O. Box 3329. ELECTRICAL REVIEW, 13 Park Row, N. Y.

STANDARD ELECTRICAL TEST INSTRUMENTS.

Ayrton & Perry Ammeters and Voltmeters,
Carpentier Ammeters and Voltmeters,
Cardew Voltmeters, Siemens' Electrodynamometers,
Queen's New Standard Laboratory Resistance Boxes,
Queen's New Portable Combination Test Sets.

COMPLETE OUTFITS FOR INSULATION TESTING.

JAMES W. QUEEN & CO., 924 Chestnut Street, PHILADELPHIA.

THACKARA MANUFACTURING CO.,

DESIGNERS AND MAKERS OF

GAS, ELECTRIC AND COMBINATION FIXTURES

For any Incandescent System.

Philadelphia, Pa.

THE SPRAGUE ELECTRIC RAILWAY SYSTEM

The Pioneer of Successful Electric Railways.

THE ONLY AWARD GIVEN FOR ELECTRIC RAILWAYS AT THE PARIS EXPOSITION OF 1889, WAS A GOLD MEDAL PRESENTED TO THE SPRAGUE ELECTRIC RAILWAY AND MOTOR COMPANY FOR THE MOST PERFECT SYSTEM OF ELECTRIC RAILWAY EQUIPMENT.

WHAT ARE THE ESSENTIAL FEATURES IN ANY COMPREHENSIVE ELECTRIC RAILWAY SYSTEM?

Main Feeders from Power Station, Main Conductor Feeding in Trolley Wire, Uniform Size of Trolley Wire, Independent of Length of Line, or Number of Cars Operated. *AND WHY?* Because, thereby only can be secured UNIFORM ELECTRICAL PRESSURE, Absolute Reliability of Service, Non-interference with one section by interruptions upon any other. The Sprague Company will guarantee to operate a ten mile, thirty car, double track system, with Less Engine Power, Less Dynamo Capacity, Less Weight of Conductors, Less Loss in Distribution, Less Loss in Motors; or in words that are understood by all, with More Car Miles Per Ton of Coal Consumed, More Miles of Line with a Given Loss, More Territory Covered by a Given Outlay, More Reserve Capacity in a Given Plant, than can be done with any other system. Features of Correct Mechanical Design Owned Exclusively by the Sprague Company: Centering the Motor on the Driven Axle, Flexible Yielding Support for Relief of Strains, Universal Movement of the Trolley Pole, Single Lever Movement for Motor Control. NO COMPETITOR OF THE SPRAGUE COMPANY CAN MAKE A SIMILAR GUARANTEE AND ACCOMPLISH IT TO THE LETTER.

SPRAGUE ELECTRIC RAILWAY & MOTOR COMPANY, Nos. 16 & 18 BROAD STREET, NEW YORK

AWARDED THE GRAND PRIZE

SEND FOR THIS BOOK
FREE ON APPLICATION.
THE BABCOCK & WILCOX CO
WATER TUBE
30 CORTLANDT ST. N.Y.
107 HOPE ST. GLASGOW, SCOTLAND.
BRANCH OFFICES
STEAM BOILERS
MANUFACTORIES IN UNITED STATES, SCOTLAND, FRANCE, GERMANY & AUSTRIA.

AT LATE PARIS EXPOSITION.

Something New! One, two, three, and four spindle drills for light work.

DRILLS

The most useful patented improvement in drill presses for years is applied.

SENSITIVE

Spindles driven with single, endless belts. Large driving pulleys, tightener and variable speeds provided.

Over 1,000 in use. Buy the **latest** and **best.** Special machinery to order. Catalogue of fine tools free.

Dwight Slate Machine Co.

HARTFORD, CONN.

THE INTERIOR ELECTRICAL CONDUIT COMPANY.

A New and Improved Method of Fitting Buildings with Insulated Tube Conduits to receive Wire for any Electrical System,

COMBINING ADVANTAGES OF

Safety, Durability, Economy, Accessibility, Convenience.

Samples, Price Lists, Catalogues and Instructions Mailed on Application.

ADDRESS

THE INTERIOR ELECTRICAL CONDUIT COMPANY,

154 and 156 West Twenty-Seventh Street, New York.

Shield Brand Moisture-Proof Line Wire

Acknowledged by all to be the **Best** Weather-proof and **Only** Moisture-proof Line Wire made. The **Shield Brand Wires** are thoroughly impervious to acids, alkalies and gases, and overcome all difficulties encountered in line construction.

THE ELLIS OIL FILTER.

The Only Perfect Oil Filter on the Market.

WE GUARANTEE:

1st.—That the Filter will clean up the same oil over and over again, returning it as pure as when first filtered.

2d.—That the filtered oil will be of as good or better quality than when drawn from the original package.

3d.—That the Filter will not require any outlay for repairs for at least six months.

4th.—That the Filter may be kept in perfect condition for an indefinite length of time at a cost of but a few cents a year.

Write for descriptive circular.

Our New Illustrated Catalogue of Electric Light and Power Supplies is the Most Complete Book of its kind Ever Issued.

THE ELECTRICAL SUPPLY CO.,

Eastern Office and Factories: ANSONIA, CONN.

Western Office and Warehouse: 171 RANDOLPH ST., CHICAGO.

Washburn & Moen Mfg. Co.

WORCESTER, MASS.

MAKERS OF

IRON AND STEEL

MANUFACTURERS OF

Iron and Copper Wire for Electrical Purposes.

PATENT GALVANIZED TELEGRAPH & TELEPHONE WIRE,

In Long Lengths, Galvanized by our Patent Continuous Process.

The Standard with all Telegraph and Telephone Companies.

Since the first introduction of the Electric Telegraph Service, our patent wire, expressly manufactured for electric purposes, has filled every requisition as regards strength, evenness of quality, and conductive capacity.

Send for Price Lists and descriptive pamphlets, and "Hand-book of Wire in Electric Service." Sent free on application.

New York Warehouse, 16 CLIFF STREET.

Chicago Warehouse, 107 & 109 LAKE ST.

NEW YORK BELTING & PACKING CO.

JOHN H. CHEEVER, Treasurer. 15 PARK ROW, NEW YORK

The Oldest and Largest Manufacturers in the United States of

VULCANIZED RUBBER

In every form adapted to mechanical purposes.

MACHINE BELTING,

With Smooth Metallic Rubber Surface

This Company has Manufactured the Largest Belts made in the World for the principal elevators at Chicago, Buffalo and New York.

We make a Superior Quality of Belting for Electric Light purposes, for use on Dynamos and Swift running machinery.

SALESROOMS.

Philadelphia, 308 Chestnut St.,
Boston, 52 Summer St.,
Chicago, 151 Lake St.,
St. Louis, 907-911 North Main St.,
Denver, 1601-1611 17th St.,
Charleston, 160 Meeting St.,
Minneapolis, 28 South 2d St.,
Cincinnati, 161-165 West Pearl St.
Cleveland, 176 Superior St.,
San Francisco, 14 & 16 Main St.,
Atlanta, 16 Decatur St.,
Detroit, 16-24 Woodward Ave.,
Baltimore, 12 North Charles St.,
Buffalo, 124-128 Washington St.,
New Orleans, 8-12 N. Peters Street.
Kansas City, 1311 & 1313 West 12th St.
Richmond, 1206 East Main St.

European Branch, Hamburg, Germany, Pickhuben 5. (Freihafengebiet).

Warerooms, 224-232 Canal St., 118-126 Walker St.,
NEW YORK.
Manufactory, Flushing & Carlton Avenues, Brooklyn.

OXLEY, GIDDINGS & ENOS,

DESIGNERS AND MAKERS OF

Electroliers and Combination Fixtures

UNSURPASSED FACILITIES

For producing fixtures of the most approved designs for any system of

INCANDESCENT LIGHTING.

Special designs furnished upon application. Suggestions from architects and decorators faithfully executed.

S. Y. L'HOMMEDIEU & CO., Eastern Agents, 65 Reade St., N. Y.

S. Y. L'HOMMEDIEU & CO., Eastern Agents, 65 Reade St., N. Y.

FARADAY CARBON CO.,

ELECTRIC LIGHT CARBONS, PITTSBURGH, PA.

COMPLIMENTS

OF THE

SEASON

TO

USERS

OF

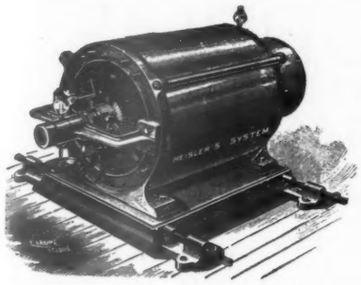
SAWYER-MAN LAMPS.

THE

HEISLER PATENT LONG DISTANCE INCANDESCENT ELECTRIC LIGHT SYSTEM

Awarded the Highest Distinction, a Gold Medal, at the Paris Exposition, 1889.

UNEQUALLED FOR DISTRIBUTION OVER WIDE AREAS.



Specially adapted for Street, Commercial and Domestic Illumination from Central Stations. Plant may be located where Power can be secured Cheapest, even if Miles Distant from the Lighting. Safety, Reliability, and Financial Success fully Demonstrated. Plan of Wiring the Simplest, Cheapest, and Most Efficient. Strictly Series. Lamps, 10 to 100 Candle Power. Long Life without Blackening. Dynamo Self-Contained and Automatic.

SEND FOR CIRCULARS. **CORRESPONDENCE SOLICITED.**

HEISLER ELECTRIC LIGHT CO., 809 to 817 South Seventh St., ST. LOUIS, MO.

THE

Double Cylinder Law Battery.

THE STANDARD FOR ALL OPEN CIRCUIT WORK.

ITS NINTH YEAR.

The Negative Element has 147 square inches of surface which is more than double the surface found in any other! The Cell contains 2½ pints of solution which is nearly double that in any other cell!

4½ ins. square, 7½ ins. high.

- No Running Over or Creeping of Salts.
- No Evaporation.
- No Corrosion.
- No Renewal of Negative Element.
- Requiring no Care.
- Costing nothing for Renewals except for Zinc and Solution (a trifle) in from two to four years.
- White Flint Glass Jar.
- Black Rubberoid Cover.
- Lock Seal Top.
- Pure Zinc.
- Pure Sal Ammoniac.
- Fewest Parts.

Success is Evidence of Merit. The Law Battery the Standard for all Open Circuit Work. The Cheapest Battery on the Market, and the Best.
The Law Battery is kept in Stock and for Sale by all Reliable Supply Houses.

AGENTS: GEO. L. HENZEL, San Francisco, Cal., for Pacific Coast.
CHAS. A. STRELINGER & CO., Detroit, Mich., for Detroit.

The Law Telephone Co., Sole Makers,

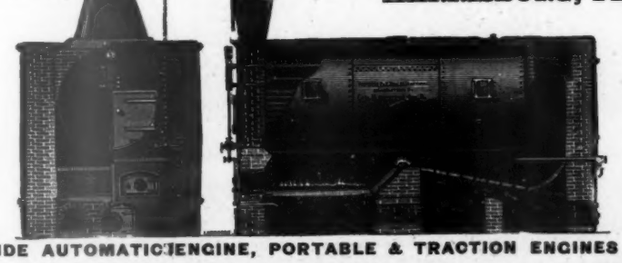
112 LIBERTY STREET, - - - - - - - - NEW YORK.

Weitmyer Patent Furnace,

MANUFACTURED AND SOLD BY

Foundry and Machine Department Harrisburg Car Manufacturing Co.

HARRISBURG, PA.



IDE AUTOMATIC ENGINE, PORTABLE & TRACTION ENGINES

STEAM ROAD ROLLERS, BOILERS OF ALL DESCRIPTIONS.

New York Office, Messrs. Fleming & Kimball, 17 Dey Street.
New England Office, Messrs. John Post, Jr. & Co., 70 Kilby St., Boston.
Baltimore Office, Messrs. Thomas K. Carey & Bro., 26 Light St., Balt.

WESTERN OFFICE, MESSRS. ENGLISH, MORSE & CO., KANSAS CITY, MO.

JOHN A. ROEBLING'S SONS CO.

MANUFACTURERS OF

Underwriters', Weatherproof, Office and Annunciator Wire.

MAGNET WIRE

AND ALL OTHER KINDS OF

Insulated Electric Wires and Cables.

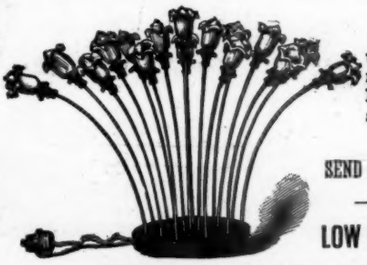
Hard Drawn and Soft Bare Copper Wire. Galvanized Telegraph Wire.
PLAIN AND GALVANIZED WIRE OF EVERY DESCRIPTION.
Iron, Steel, Copper and Galvanized Wire Rope.

JOHN A. ROEBLING'S SONS CO.,
NEW YORK OFFICE AND WAREHOUSE, 117 & 119 LIBERTY ST.,
H. L. SHIPPY, Secretary.

Chicago Office & Warerooms, 171-173 Lake St., Geo C. Bailey, Manager. | WORKS: TRENTON, N. J. | San Francisco Office & Warerooms 8 California St., S. V. Mooney, Manager.

Edison Lamps

½ to 36 CANDLE POWER.
2½ to 40 VOLTS.
For Battery or Dynamo.



These Lamps can be used in Series on Dynamo Circuits for all kinds of Decorations and Displays.

SEND FOR CATALOGUE
— OF —
LOW VOLT LAMPS

EDISON LAMP CO., HARRISON, N. J.

CARBON PLATES & CARBON BATTERIES

ELECTRIC LIGHT CARBONS.

MADE FROM NATURAL GAS BY PATENTED PROCESS.

— ADDRESS —

SOLAR CARBON & MANUFACTURING CO.,
95 & 97 FIFTH AVE., PITTSBURGH, PA.

JOHN W. MASON, Manager.
SPECIAL AGENTS

OKONITE
TRADE MARK.
WIRES AND CABLES.

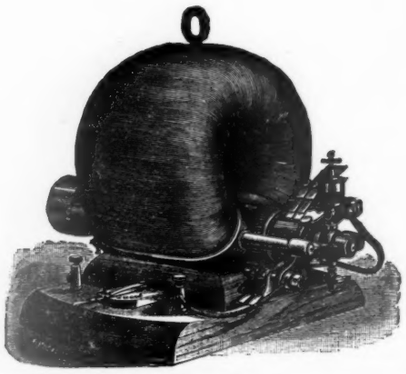
GATE CITY ELECTRIC COMPANY
— HAVE A FULL STOCK OF —
ELECTRICAL SUPPLIES
And will make LOW Prices and PROMPT Shipments.
522 DELAWARE ST., - - KANSAS CITY, MO.

FOR ✣ CHRISTMAS!

Treat yourself to a luxury by buying a Paillard Non-Magnetic Watch and be the happy possessor of "a thing of beauty and a joy forever." These Watches are made in Open Face and Hunting, and cased in Gold, Gold Filled and Silver, at prices as low as a reliable Watch can be bought, to the most expensive. Paillard Non-Magnetic Watches cost no more than other makes in equal grades, and in construction, finish and fine timekeeping qualities EXCELL THEM ALL.

FOR SALE BY ALL JEWELERS.

THE EDDY ELECTRIC M'F'G CO.
MANUFACTURERS OF



AUTOMATIC ELECTRIC MOTORS,

In all sizes, from 1-2 H. P. upward; High Efficiency; Perfect Regulation; Superior Workmanship; Ease of Management; Remarkable Simplicity, etc., etc.

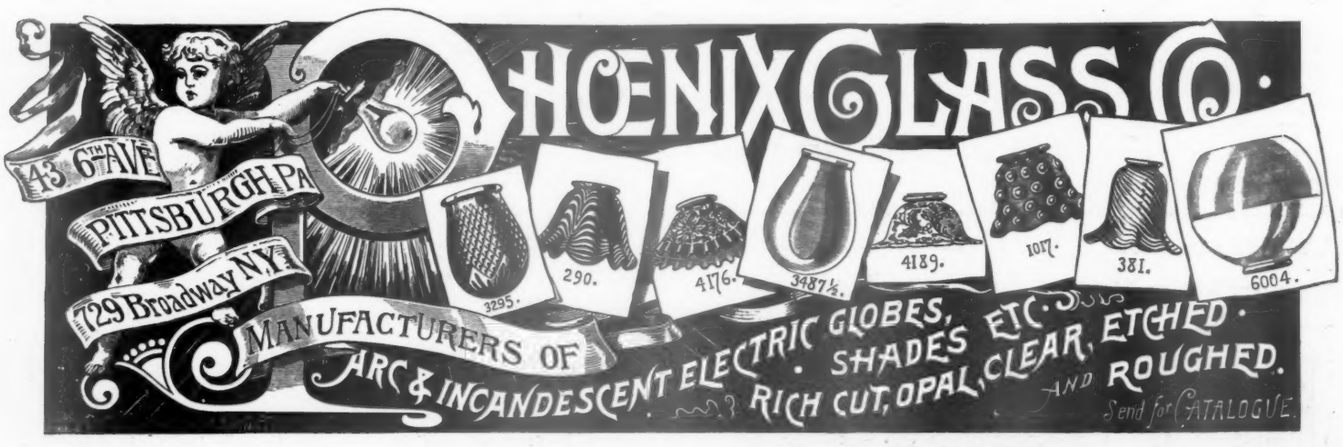
DYNAMO ELECTRIC MACHINES,

For Electro-Plating, Electrotyping, Copper Refining, Etc. No Reversing. No Water. No Noise. No Spark.

SATISFACTION GUARANTEED.

THE EDDY ELECTRIC M'F'G CO., WINDSOR, CONN.

NEW YORK, 33 Church St., BOSTON, 111 Arch St., PHILADELPHIA, 506 Commerce St.,
CHICAGO, 42 La Salle St., KANSAS CITY, Rialto Building, NEW ORLEANS, 106 Carondelet St.



Porcelain Electrical Supplies and Specialties,
MANUFACTURED BY
EMPIRE CHINA WORKS,
144 & 156 Greene St., GREENPOINT, BROOKLYN, E. D., N. Y.
Our Ware is HARD PORCELAIN, the BODY and GLAZE IDENTICAL, and GUARANTEED NON-CONDUCTIVE for all ELECTRICAL PURPOSES.

All GENUINE INGOTS & MANUFACTURES BEAR OUR REG. TRADE MARKS.
Phosphor Bronze

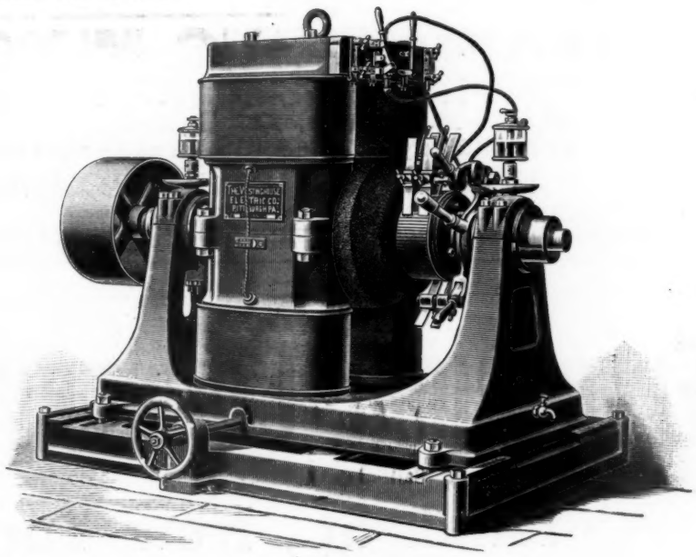
PHOSPHOR-BRONZE
INGOTS, CASTINGS & MANUFACTURES.
THE PHOSPHOR BRONZE SMELTING CO. LIMITED
512 ARCH ST. PHILADELPHIA PA. U.S.A.
ORIGINAL MANUFACTURERS OF PHOSPHOR-BRONZE IN THE UNITED STATES AND OWNERS OF THE U.S. PATENTS.

THE

Westinghouse Electric Co.'s System for Arc Lighting.

IMPROVED WATERHOUSE APPARATUS.

Automatic Regulation from One Lamp to Fifty Lamps.



IMPROVED LAMPS.

ESTIMATES FURNISHED ON APPLICATION.

THE

WESTINGHOUSE ELECTRIC CO.

Pittsburgh, Pa., U. S. A.,

BOSTON, NEW YORK, CHICAGO, ST. LOUIS, CINCINNATI,
SAN FRANCISCO, PORTLAND, CHARLOTTE, DALLAS.

Fort Wayne Electric Company,

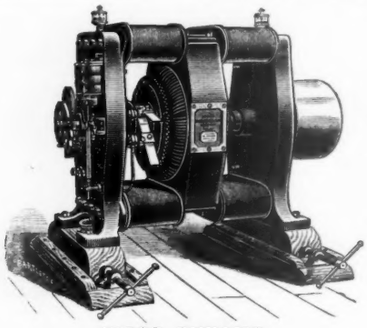
FORT WAYNE, IND.

The most carefully worked out and Complete Alternating System of Electric Lighting in existence.

ARMATURES AND CONVERTERS GUARANTEED.

12 16-candle-power Lamps to the mechanical horse power guaranteed

CORRESPONDENCE SOLICITED.



WOOD DYNAMO.

MANUFACTURERS

—OF THE—

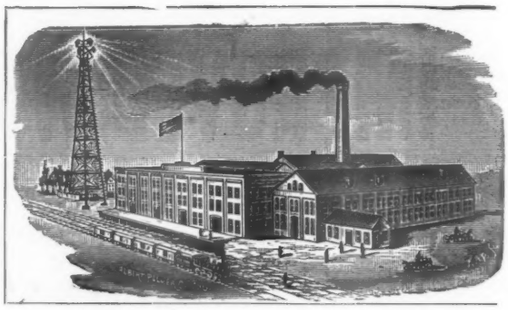
Slattery Induction System

OF INCANDESCENT LIGHTING,

—AND THE—

"WOOD" SYSTEM

OF ARC LIGHTING.



Main Office and Works, Fort Wayne, Ind.

NEW YORK OFFICE, Rooms 25 and 27, 115 BROADWAY,

H. C. ADAMS, Manager.

Manhattan Electric Light Co., 511 Broadway, Sole Licensees and Agents for N. Y. City and Brooklyn

CHICAGO OFFICE, 185 Dearborn St., *W. J. BUCKLEY, Manager.*

PHILADELPHIA OFFICE, 907 Filbert St., *G. A. WILBUR, Manager.*

SAN FRANCISCO OFFICE, 217 Sansome St.

F. ADAMS SUC'S, CITY OF MEXICO.

THE

TUCKER ELECTRICAL CONSTRUCTION CO.

14-20 Whitehall St., New York City.

* * * * * * * * * * * *

CONTRACTORS FOR

HIGH GRADE CONSTRUCTION WORK.

* * * * * * * * * * * * *

Correspondence of Electric Light Companies Solicited.

Refer to some of the Most Prominent Buildings in New York City.